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FOUNDATIONS OF
COLLEGE GEOGRAPHY

VOLUME I

By

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"Geography is the exact and organised knowledge of the distribution of Phenomena on the surface of the earth, culminating in the explanation of the inter-action of Man with his terrestrial environment."—Hugh Robert Mill.

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PREFACE

No apology is needed for bringing out this book for use as a general text in the Intermediate Classes of Indian Universities and Education Boards. There was practically no one book containing all that an average Indian student of the Intermediate Classes requires. One has to go from one book to another written by different authors or take resort to bazar notes and help books. The book is, therefore, fulfilling a definite need.

Wide use of books by competent authorities is inherent to a work of this nature and the authors have freely drawn from all available literature on the subject. A list of books which have been consulted and from which useful matter has been taken is given at the end. Occasional acknowledgements also occur in the text.

The arrangement and the treatment of matter is scientific and the human element of Geography has constantly been in our minds. Natural Regions have been given as the last Chapter in the Economic and Human section-a step which is certainly a diversion from the scheme, followed in general books. Opinions both for and against the step are specially invited from well-wishers of Geography.

The book had to go hurriedly through press and some mistakes of print, expression or even facts might have crept in for which the indulgence of the reader is craved.

On account of the exhorbitant cost of block-making and printing, many diagrams and maps could not be given and a better type could not be used. The war-time difficulties of the publishers can hardly be exaggerated.

The authors are well conscious of the short-comings of the present edition and shall be obliged for useful suggestions and healthy constructive criticism from teachers which we shall try to incorporate in subsequent editions of this book.

Lahore :
The 25th May, 1944.

M. NAZIR
V. S. MATHUR

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CHAPTER I

MATHEMATICAL GEOGRAPHY

SECTION A

(*a*) **The Universe** includes all ‘material things’, our earth being only a part of that big universe. All the large bodies of the universe are called ‘stars.’ The sun which is also a star seems largest to us only because it is nearest the earth—the distance between the two bodies being about 93,000,000 miles. The light of the sun reaches us in about five hundred seconds—light travels at the rate of 186,000 miles per second.

Other stars are very far away from us and their light takes very long to reach us. The light of the North Star, it is said, takes about 47 years to reach us on the earth.

(*b*) **The solar system** or the ‘sun system’ is a family

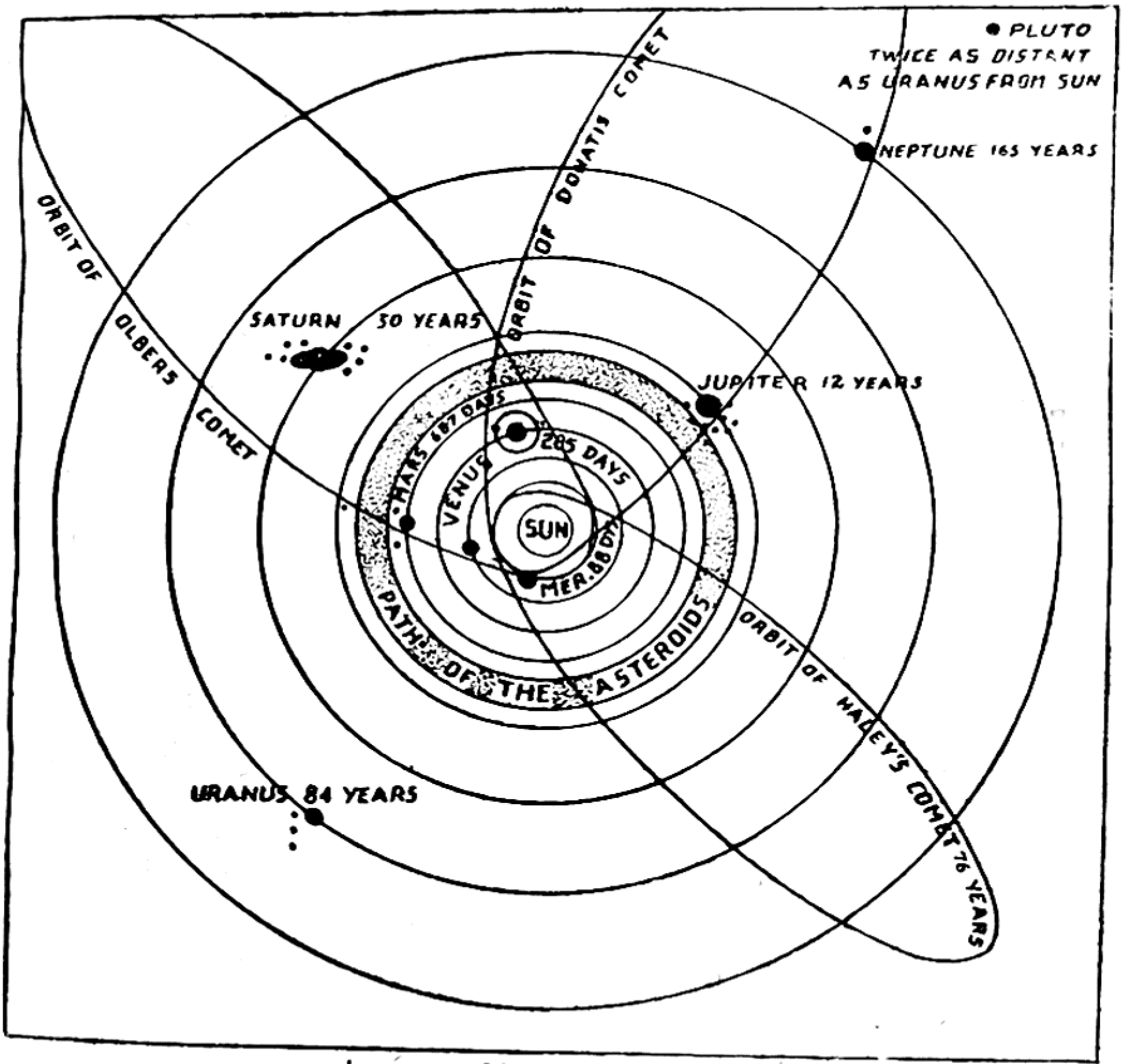

Fig. 1 —The Solar System

of spherical heavenly bodies with sun as its centre. Besides the sun it consists of planets, moons or satellites, planetoides, comets and meteors.

The sun has a diameter of 864,392 miles and is many times greater in size than all the planets combined as may be judged from figure number two. The sun and other stars have their own lights. The sun is so hot that though it is very far away from us, yet it is the light and heat of the sun that makes life possible on the earth.

The **planets**[1] are bodies that revolve round the sun and reflect its light. The nine planets in order from the sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Jupiter is the largest—its diameter is more than ten times the diameter of the earth.

Some astronomers tell us that there may be life in Mars. Mercury is too hot for life; Venus has no water; Jupiter, Saturn Uranus, and Neptune are too cold to support life.

The solar system as a whole is moving through space. The sun and the planets are rotating on their axes. The earth completes one rotation in about 24 hours; the sun in about 25 and a half days and Jupiter in about ten hours.

The *orbit* on which the planets revolve round the sun is an ellipse and the sun is not exactly in the centre. This causes what are called the 'Perihelion' and the 'Apheljon' distances, that is, in the former position the earth is nearer the sun and in the latter it is farther away (Fig. 31).

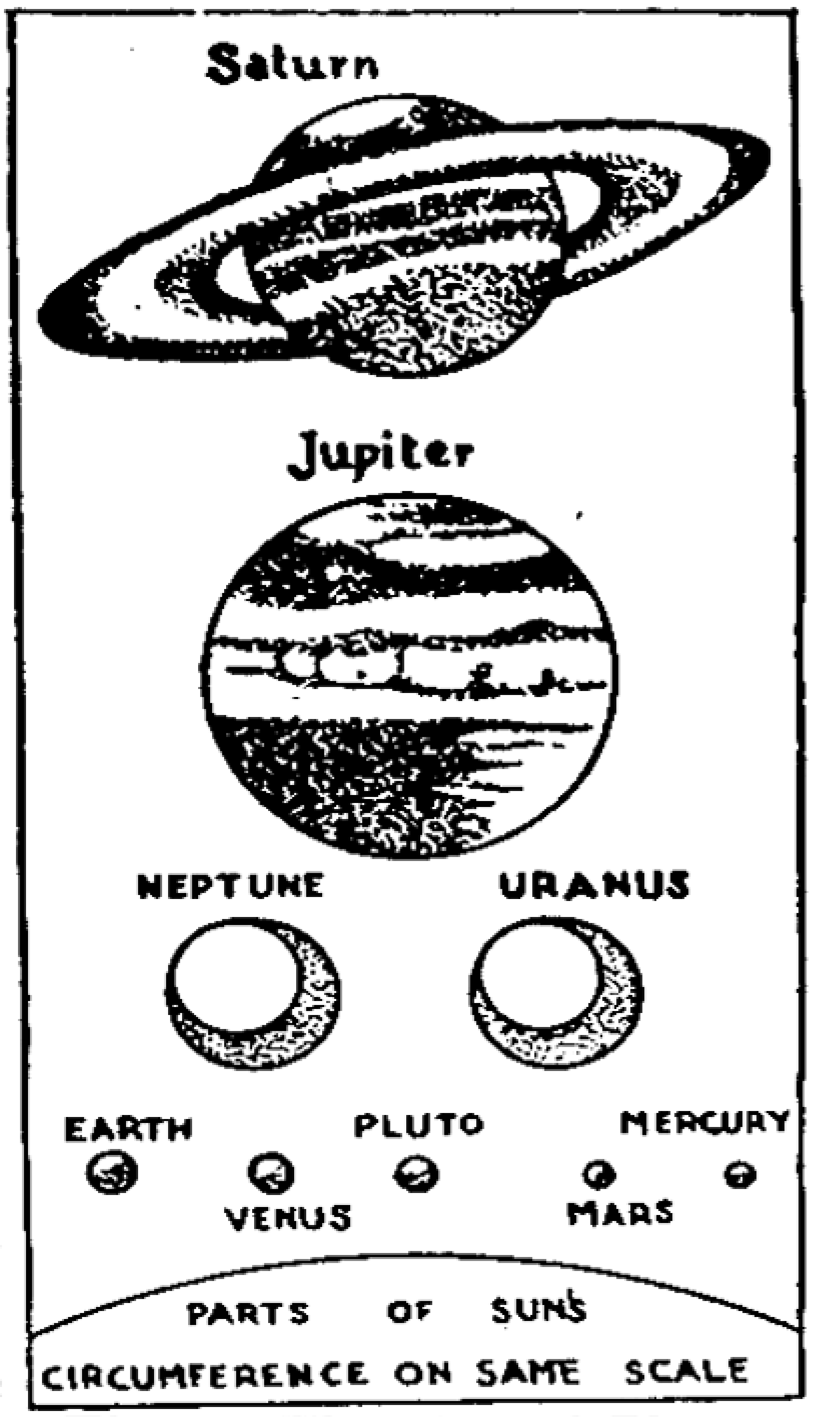

Fig. 2—The size of Planets

Moons or Satellites are heavenly bodies which besides rotating on their respective axes, also revolve round the planets. Every planet has its own set of moons. We have only one moon and it is situated about 240,000 miles away from the earth. It also reflects the light of the sun.

Planetoids are small planetlike bodies, their diameters varying from 5 to 500 miles. About 1,200 planetoids are known so far. Planetoids revolve round the sun between Mars and Jupiter:

---

[1] A number of Asteroids have been discovered. There vary in size and their mean distance from the earth is 28·5 millon miles.

Comets are luminous bodies having quite a long tail and following an orbit about the sun.

Meteors are shooting stars or solid bodies that become heated and visible as they pass through the atmosphere of the earth.

Northern lights :—During clear nights, more especially during winter, the northern part of the sky is sometimes illuminated by an arch of rosy light. One also sees moving streamers of light, whitish or coloured between the arch and the higher parts of the sky. This phenomenon is known as 'northern lights' or the 'Aurora Borealis.' It is, however, more distinct in high northern latitudes. A very similar appearance in southern latitudes is known as 'aurora Australis.' It is believed that this auroral display in both the above cases is due to "a faint electric discharge controlled by the magnetic forces of the earth."

Sun spots : Sometimes we see a number of dark spots on the face of the sun. They are called 'sunspots.' Actually they are electric explosions and storms giving out more heat than other parts.

Gravity and gravitation :—The attraction that is exerted by the earth on all bodies upon it, is termed 'surface gravity.' Everything is attracted towards the centre of the earth. It eventually causes what we call *sea-level.*

Heavenly bodies also exert an attraction upon each other. The earth exerts an attraction upon the moon and the moon upon the earth. This mutual attraction of bodies has been termed *attraction of gravitation.* The law of gravitation was discovered by Newton about two centuries ago. The degree of this gravitation depends both on masses and the related distances of the attracting bodies.

SECTION B

THE EARTH AS A GLOBE

(*a*) **Shape and size of the earth.**—The earth is spherical or round in shape but it is not a perfect sphere, being flattened at the poles. How do we know that the earth is round? Our ancestors believed that the earth was flat like a table, which was perhaps due to the fact that man can only see a very tiny part of the surface of the earth which looks flat. But not very long after, it was found that the horizon is curved and eventually people gathered ample evidence to prove the roundity of the earth. Aristotle made a very clever use of the eclipses of the moon to determine the shape of the earth. He noted that during a lunar eclipse the edge of the earth-shadow on the moon is an arc and thus he concluded that the earth must be having a curved surface, such as a globe has. Below are details of some of the more noted proofs of the earth's being a sphere.

1. The hulls of outgoing ships disappear everywhere at the same rate.

2. The circular horizon expands according to the increase in the altitude of the observer. An attempt has been made to illustrate this point in fig. 3.

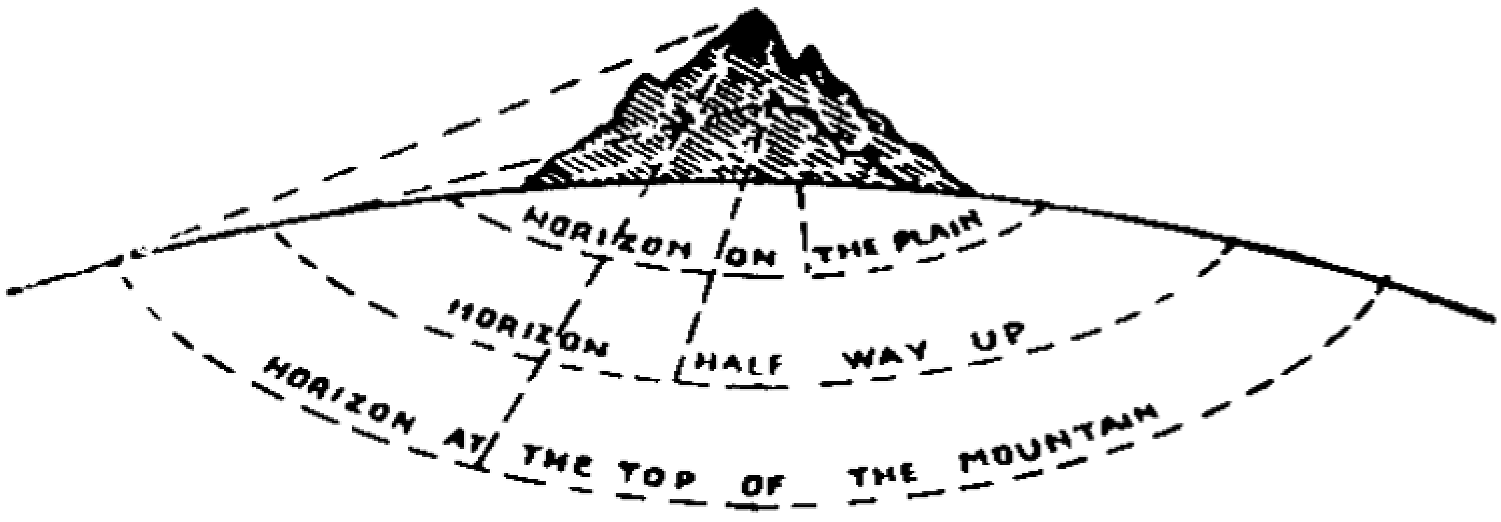

Fig. 3

3. Figure 4 illustrates the experiments carried out by Wallace and Yale Oldham. In both the experiments three poles of equal heights were pitched in water in such a way that equal portions remained above water. When seen through a telescope the tops of the poles made a curve and not a straight line.

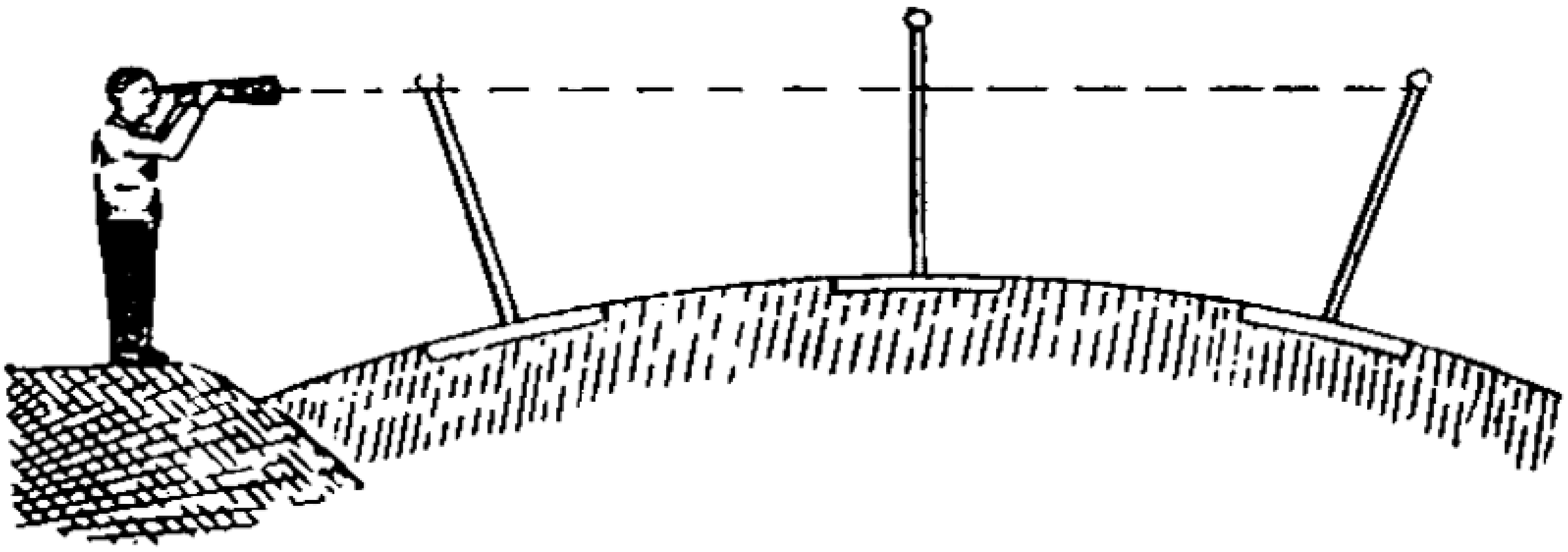

Fig. 4

4. The difference in mid-day time varies uniformly with angular distances East and West.

Careful measurements and observations have, however, shown that the earth is not a perfect sphere, being lightly flattened at the poles and having a bulge round the equater. This phenomenon has been illustrated in fig. 5. Technically the shape of the earth is known as a *geoid* or an *oblate spheroid.* But for all practical purposes we ignore the slight variation and say that the earth is 'round.'

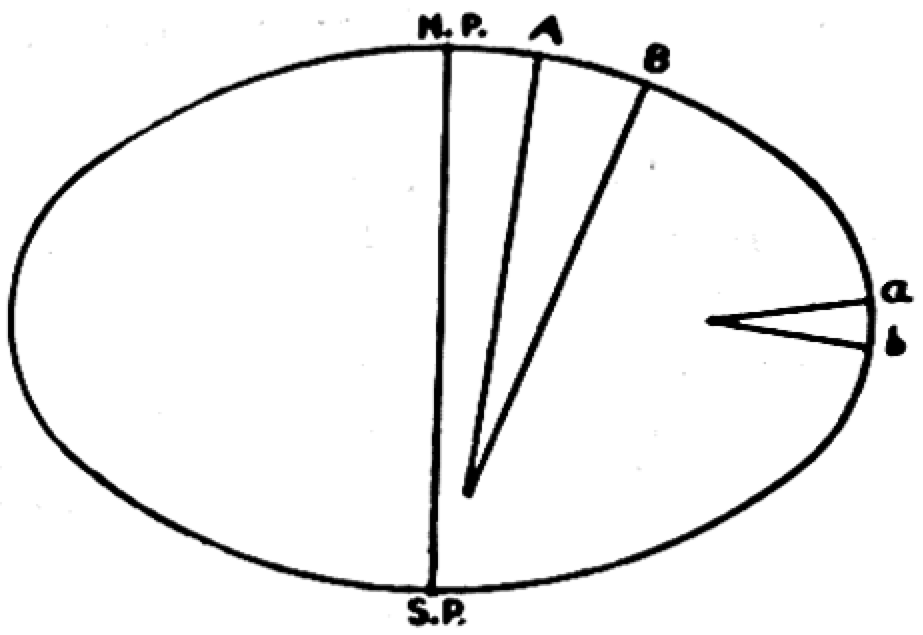

Fig. 5—Flattening at the Poles

For many a year people tried to find out the size of the earth but Eratosthenes was the first person to measure the circumference of the earth with accuracy. The work must have been very difficult to complete in those days, about 2,000 years ago, but to-day it seems simple enough. He knew that the earth is round and he also knew that a circle contains 4 right angles, that is, 360 degrees. On a mid-summer day, at noon, he noticed that the sun at Alexandria was exactly overhead while at a place called Assuan it was making an angle of 6½ degrees from the zenith. The distance between the two places was about 450 miles. Thus the arc between the two places is 450 miles long and substends an angle of 6½ degrees at the centre of the earth (fig. 6A). Therefore the whole circumference, that is

$$360 \text{ degrees} = \frac{(360 \times 450 \times 2)}{13} = 24{,}923 \text{ miles.}$$

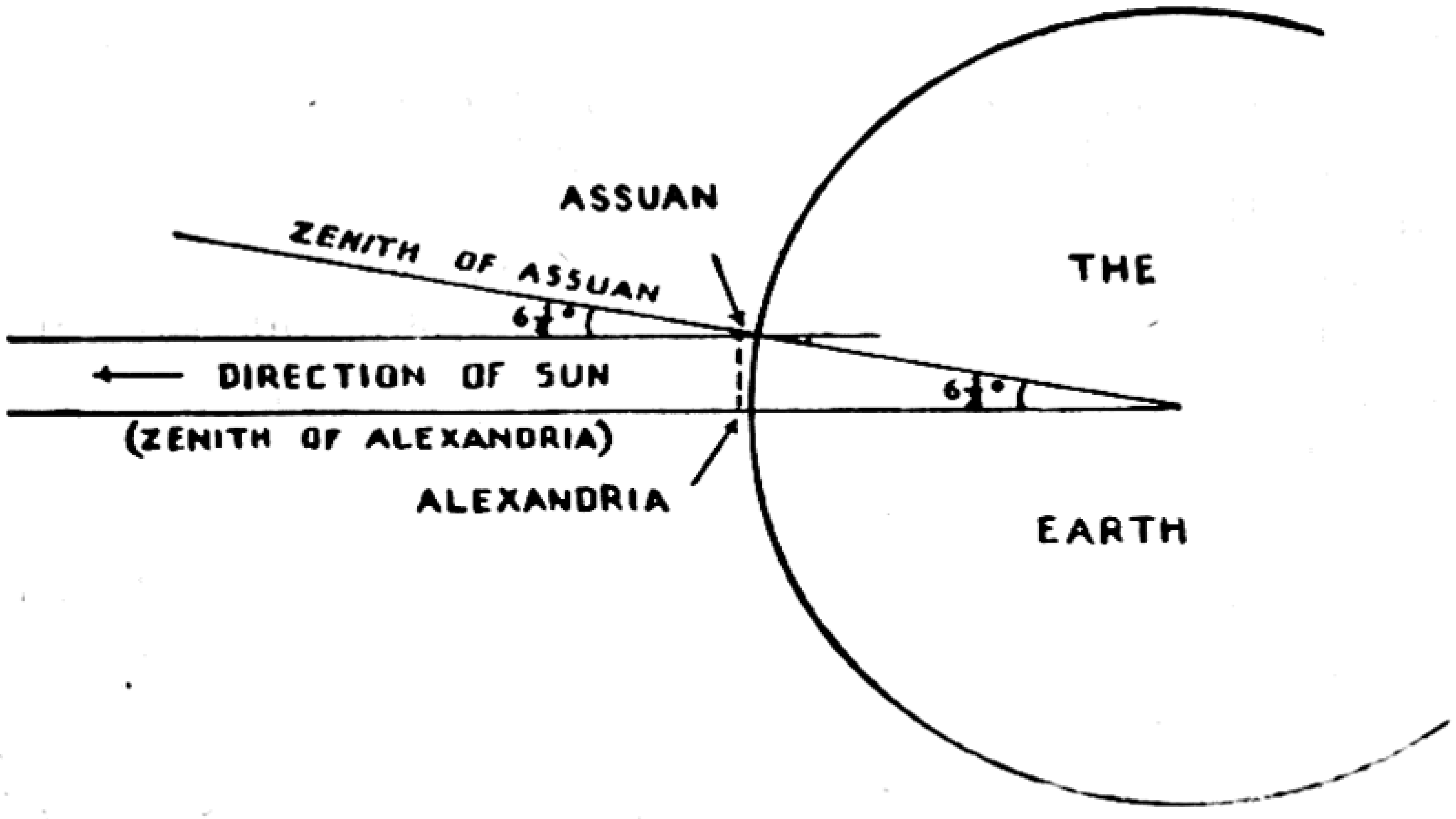

Fig. 6A—Eratosthenes' method

This experiment can be done by anybody at any place. Just find out the difference in the height of the sun at two places, situated at a different latitudes and also find out the distance between them in miles. The rest of the calculation is easy.

But for all practical purposes we take 25,000 miles as the circumference of the earth. The polar circumference is about 42 miles less than the circumference at the equator.

Owing to the same reason the polar diameter is about 26 miles less than the equatorial diameters.

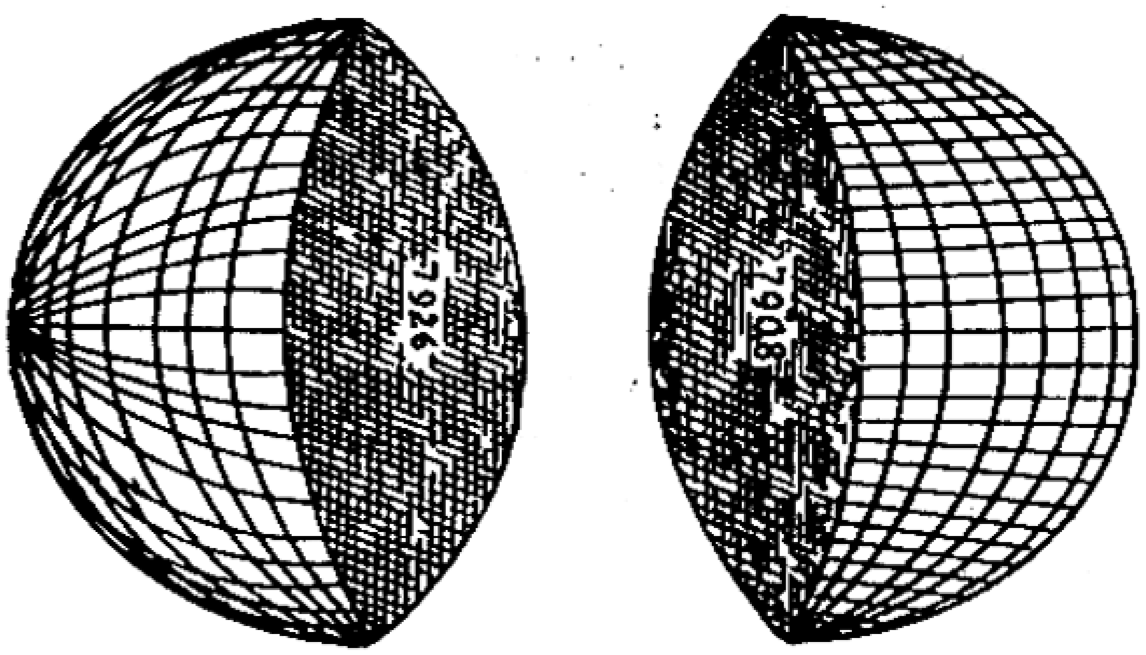

Fig. 6B—The polar and the equatorial diameters

Below are given the principal dimensions of the earth :—

Polar diameter of the	earth	7,900 miles
Equatorial diameter	,,	7,926 ,,
Mean diameter	,,	7,913 ,,
Circumference	,,	25,000 ,,
Volume of the earth	,,	262,000,000,000 cubic miles
Surface of the earth	,,	197,000,000 sq. miles
Land surface	,,	57,000,000 ,, ,,
Ocean surface	,,	140,000,000 ,, ,,

(*b*) **Distribution of land and water.**—The total surface of the earth as shown in the table above is about 197,000,000 sq. miles, out of which about 71% *i.e.*, 140,000,000 square miles is covered by oceans and seas while only 29% consists of land. The water area consists of five oceans and many gulfs, bays and seas; while the land is divided into 7 continents and many islands. The following tables show the areas of the various continents and the oceans.

Table No. 1

Continent	Area.
(1) Asia and its islands	17,000,000 sq. miles.
(2) Africa	11,500,000 ,, ,,
(3) North America and its island	9,000,000 ,, ,,
(4) South America	7,200,000 ,, ,,
(5) Antarctica	5,000,000 ,, ,,
(6) Europe	3,900,000 ,, ,,
(7) Australia	3,000,000 ,, ,,

Table 2.

Oceans	Area
(1) Pacific ocean	... 54,000,000 sq. miles
(2) Southern ocean	... 35,000,000 ,, ,,
(3) Atlantic ocean	... 28,000,000 ,, ,,
(4) Indian ocean	... 18,000,000 ,, ,,
(5) Arctic ocean	... 5,000,000 ,, ,,

The positions of the above may be ascertained from any good atlas if the reader is not already acquainted with them.

(*c*) **The Hemispheres.**—Most of the students know only of the Northern and Southern Hemispheres but these are not the only hemispheres. One could find out the truth of it by a study of the globe. Every member of the class, as he looks at the globe, sees a different hemisphere. (Hemisphere means Half of the Earth). By placing himself directly in regard to the North and South Poles he can find the Northern and the Southern Hemispheres respectively. He will observe that both are bounded by the equator. By looking directly at the seventy degree east meridian one can easily observe the Eastern Hemisphere, and by looking at 110 degree West meridian he could observe the Western Hemisphere. If we look directly at London we find that this is the Land Hemisphere. By turning the globe, round to exactly the opposite position, the Water Hemisphere may be seen.

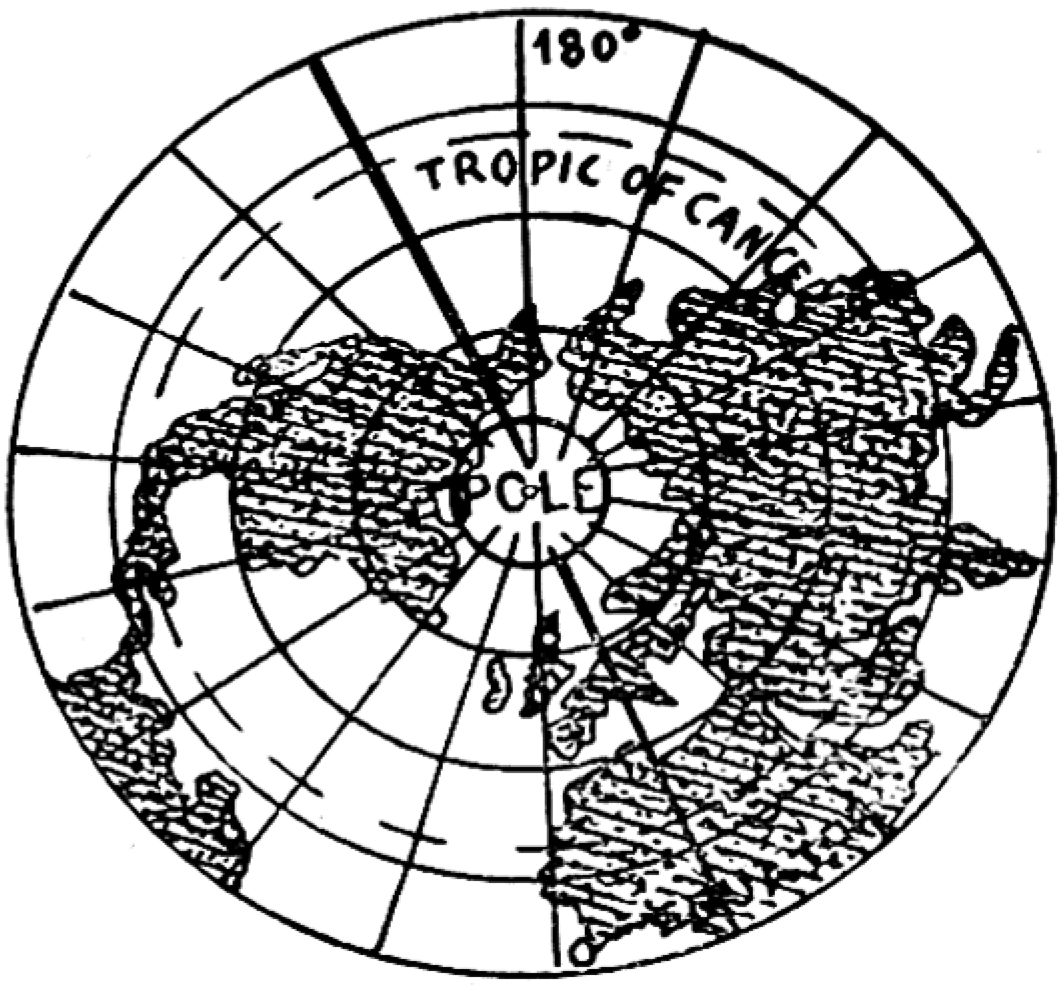

Fig. 7—Northern Hemisphere

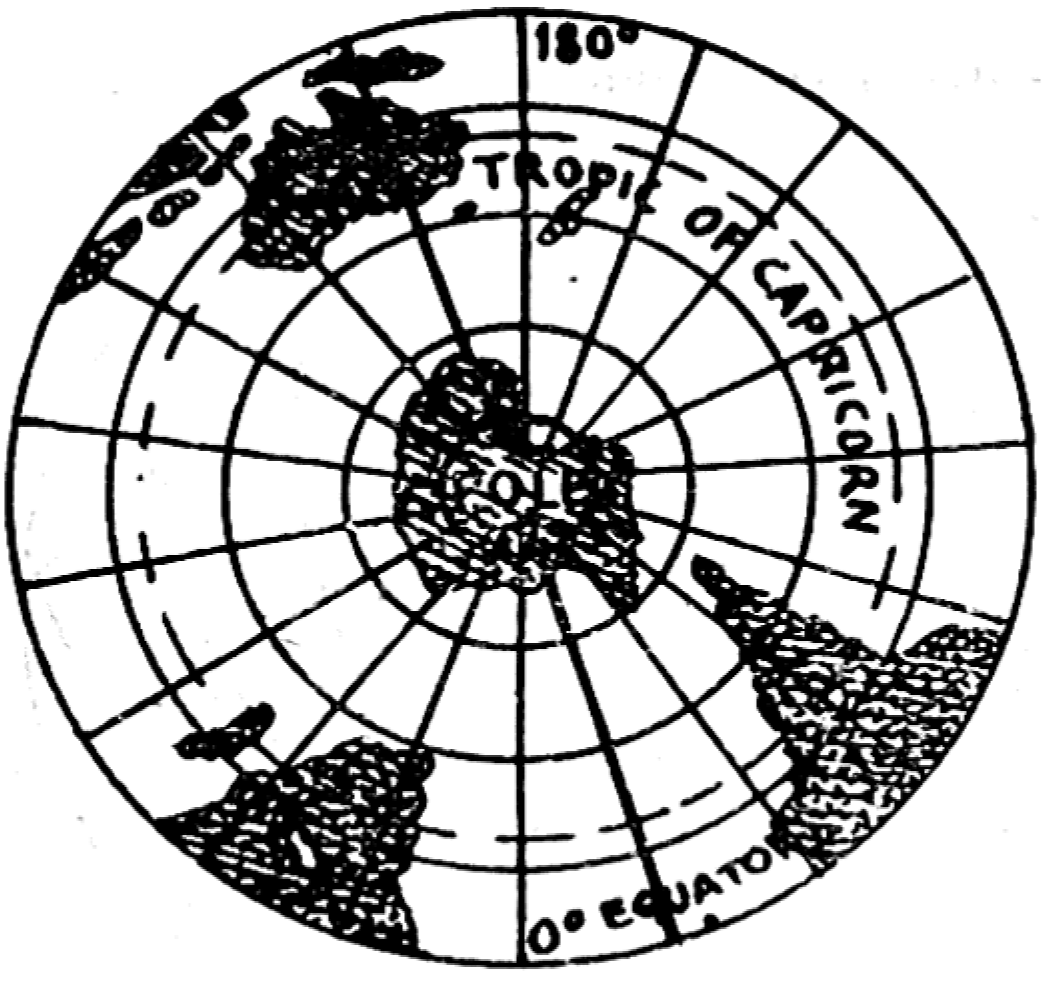

Fig. 8—Southern Hemisphere

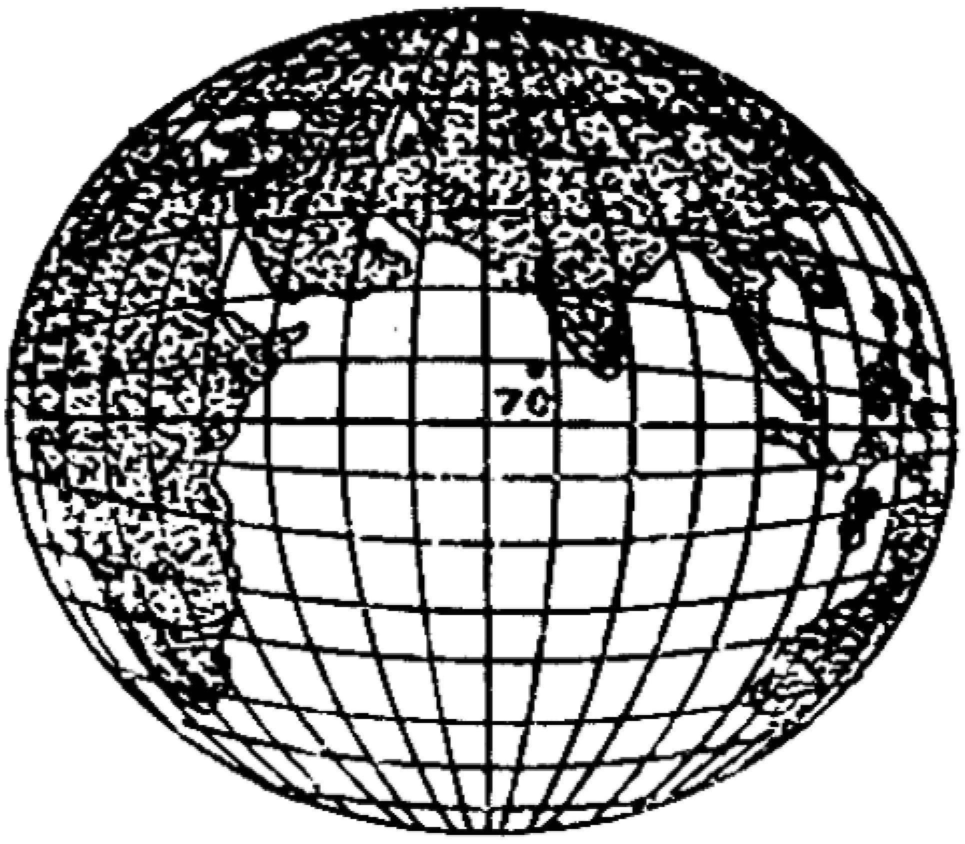

Fig. 9—Eastern Hemisphere

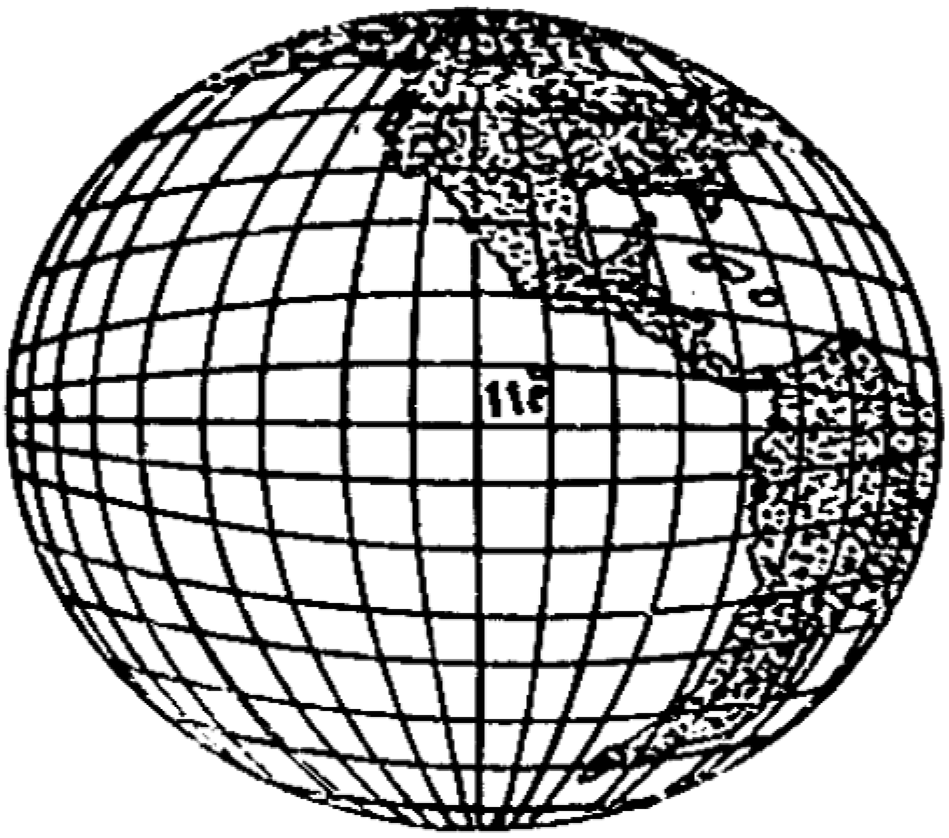

Fig. 10—Western Hemisphere

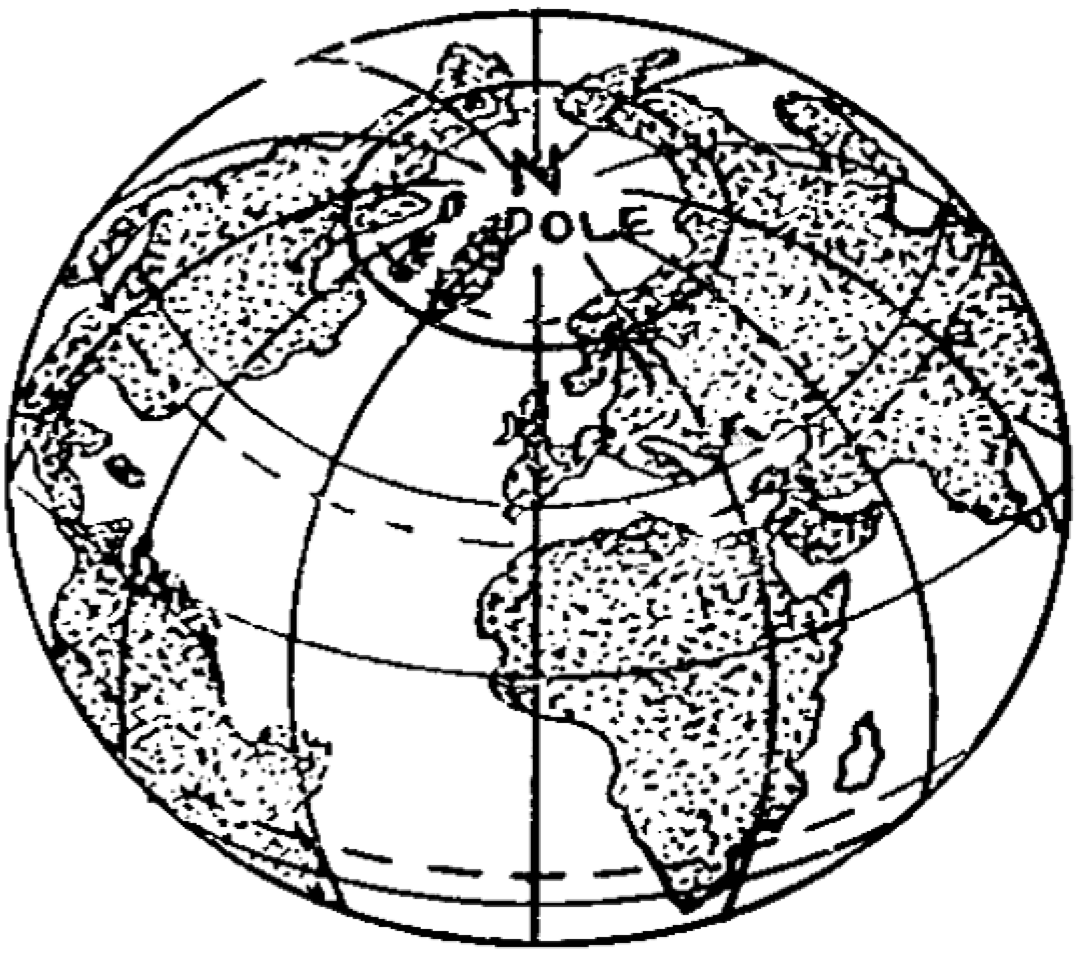

Fig. 11—Land Hemisphere

The Northern Hemisphere contains two-third of the land and the Southern Hemisphere about one-third. Nine-tenth of the people of the world live in the Northern Hemisphere and one-tenth in the Southern.

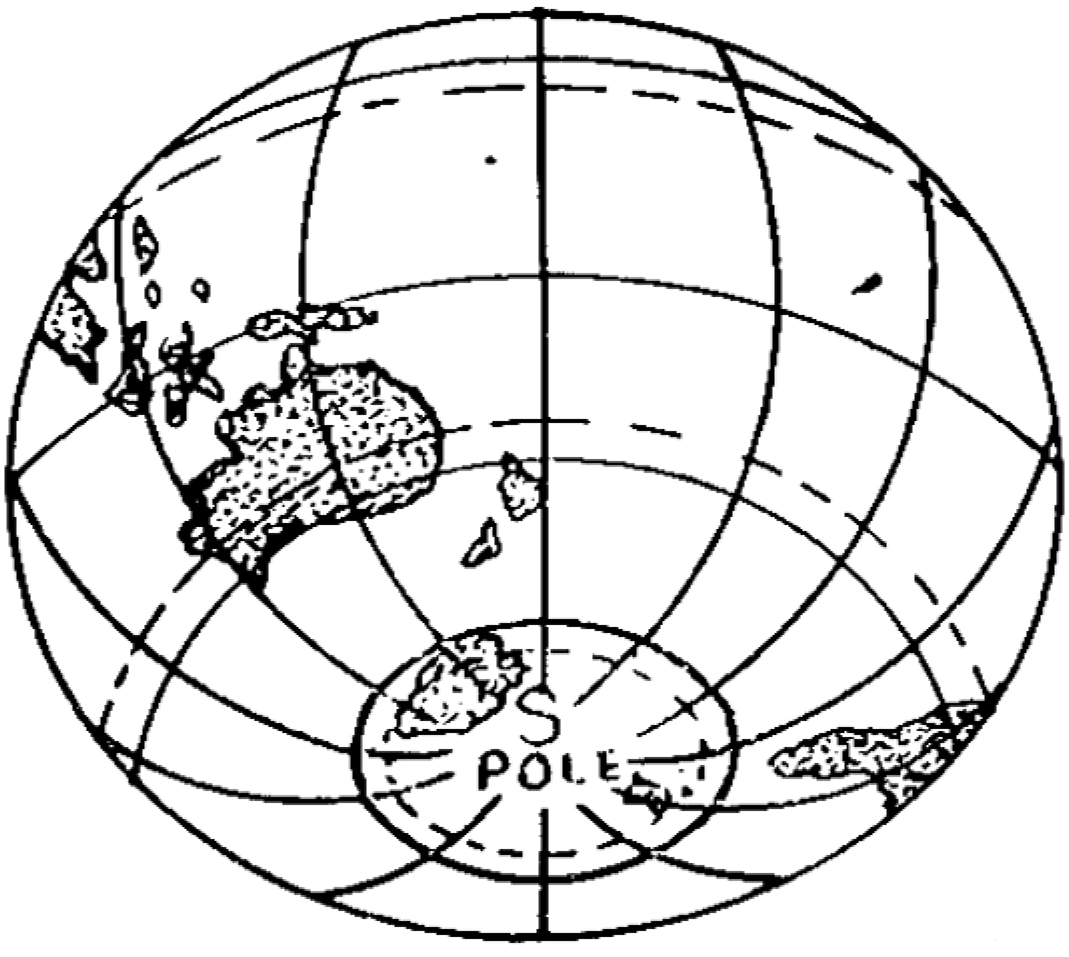

Fig. 12—Water Hemisphere

(*d*) **Latitude and longitude.**—Take a piece of paper and put on it a dot somewhere. Now if you are asked to describe the exact position of the dot on the page, how will you explain? You can do this by giving its distances form the bottom and any one side of the paper.

In the same way you could find out the position of any other point on this piece of paper. Similarly in order to find out the position of any place on the Earth we have to imagine two lines, one vertical and the other horizontal, cutting each other at right angles. The horizontal line is the Equator and the vertical line can be any line joining the two poles. But for the sake of convenience the line passing through Greenwich is taken as the standard and is called the *Prime Meridian.*

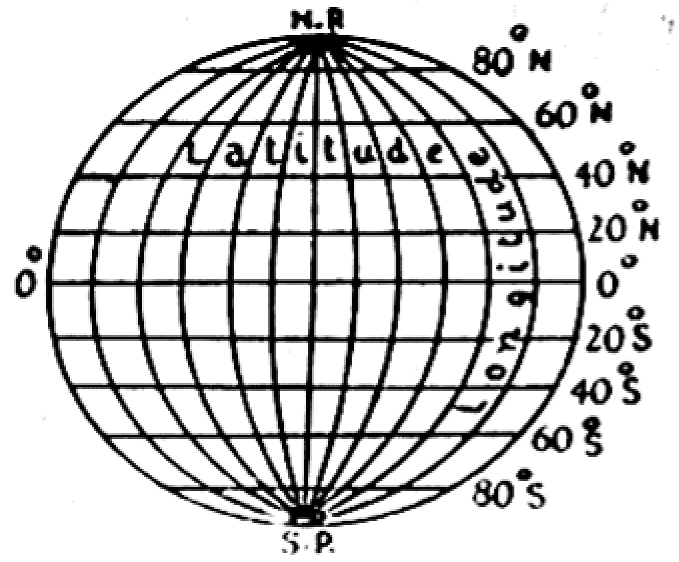

Fig 13—Latitude and longitude

The distance of a place from the equator North or South of it is called the *latitude* of that place, and its distance from the prime meridian East or West of it, is called its *longitude.* See Fig. 13.

But because of the fact that the earth is round, equator is a circle and the prime meridian is a semicircle, the distances from the equator and prime meridian are measured in degrees. In order to facilitate the work of map drawing and in order to find out the directions of places on maps and globes, concentric circles are drawn parallel to the equator—*parallels of latitude.* On a map parallels of latitude are drawn usually at intervals of ten degrees.

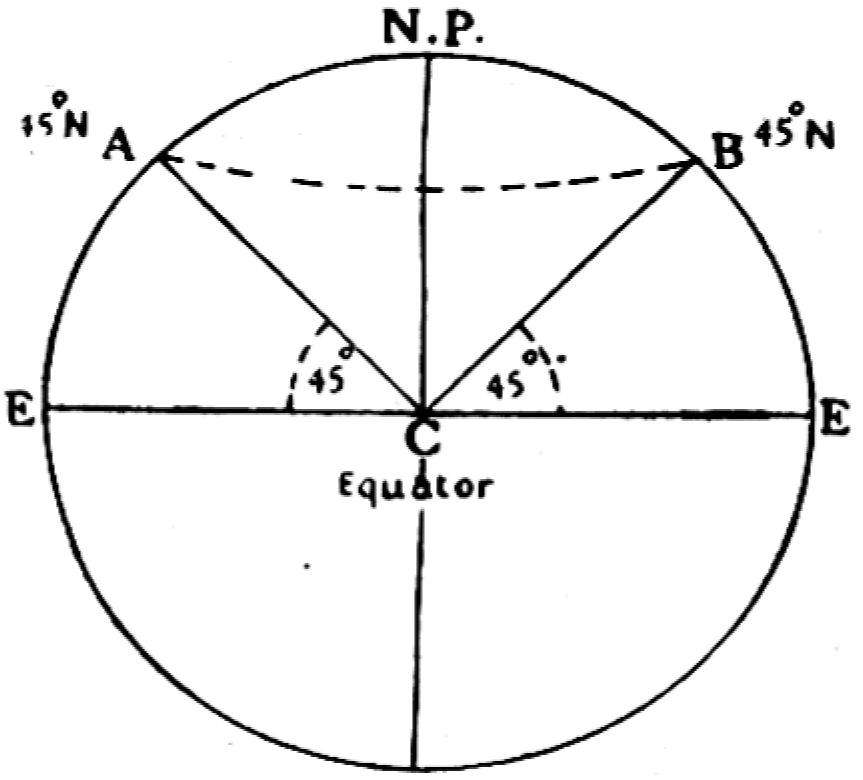

Fig. 14—Drawing a parallel of latitude

Similarly many semicircles are drawn joining the poles and meeting the equator at equal intervals. These are used for finding the longitude and are called *meridians of longitude.* These lines are usually marked on the globe at intervals of fifteen or twenty degrees from the prime meridian. Going East and West from the prime meridian, a common meridian would be reached at 180 degrees. This

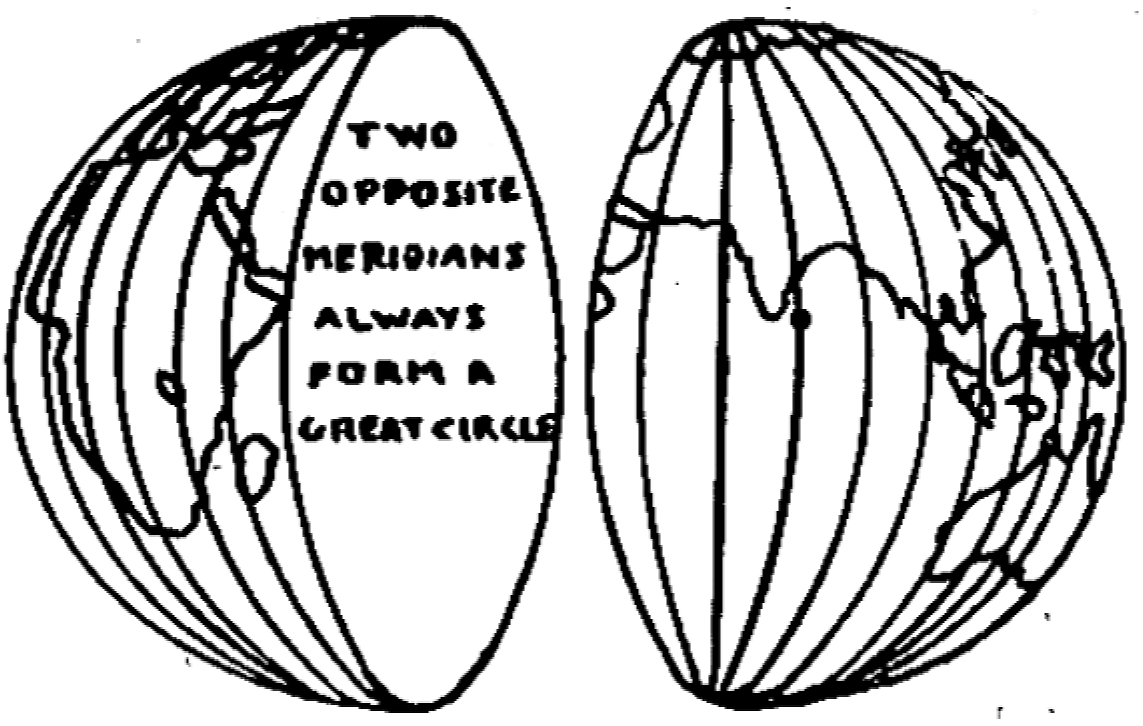

Fig. 15—Great circles

meridian of 180 degrees and the prime meridian together from a *great circle* (Fig. 15).

As the earth is round and all the meridians have to pass through the north and south poles, the distance between any two meridians increases towards the equator where it is the greatest, *i.e.*, about 69 miles for every one degree. At the poles all the merideans meet where the distance between any two of them is nil.

We might add here that owing to the flattening at the poles and the bulging round the equator, there are differences in the measurement of the degree. Hence the length of the degree of latitude at the equator is slightly smaller than that of a degree of longitude. You should know by now that the latitude is measured along meridians of longitude and that longitude is measured along the parallels of latitude.

The distinction between longitude and latitude can be easily remembered. Longitude runs to 180 degrees while latitude runs only upto 90 degrees.

We can locate ships if we know their respective latitudes and longitudes which are regularly wirelessed by them.

(*e*) **Great and small circles.**—We have already seen that each meridian with its complement makes a complete circle, cutting the globe in two equal halves called hemispheres. Such a circle is known as a 'great circle.' The equator is also a great circle because it is drawn halfway between the poles. All other parallels of latitude divide the globe into unequal parts and are known as *small circles*. Nearer they are to the equator, greater is their circumference. (Figure 16).

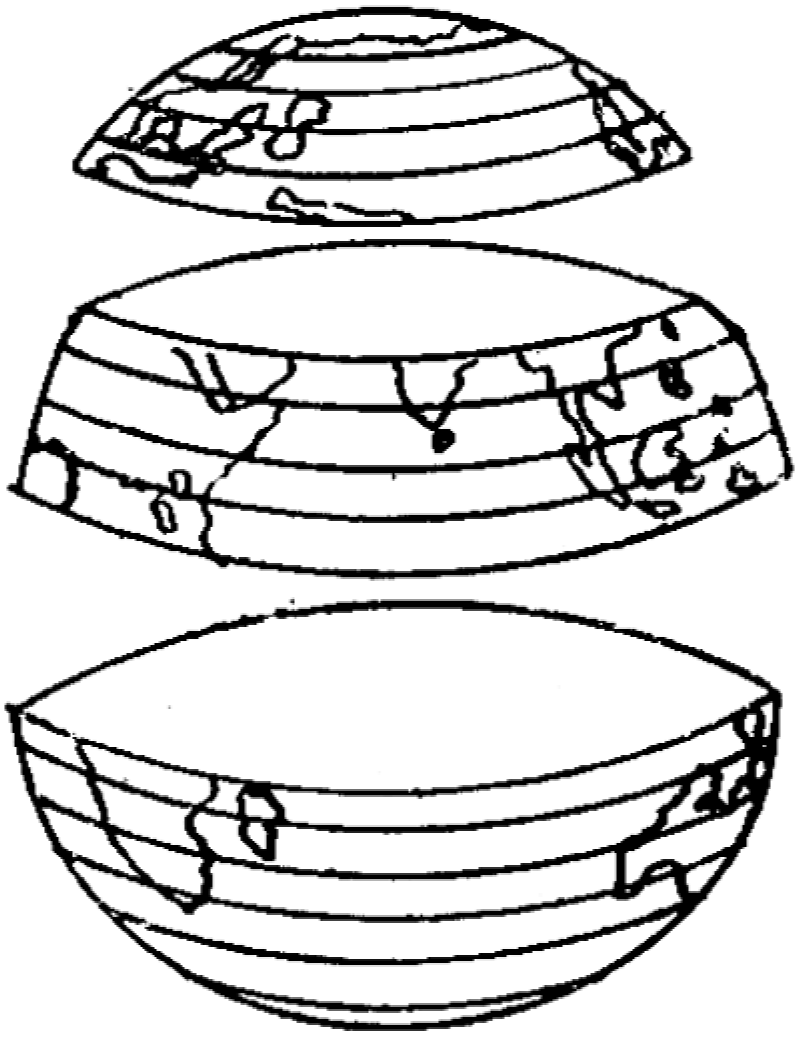

Fig. 16—Small circles

(*f*) **Determining latitude.**—There are several ways of derermining latitude or of finding out the angular distance of any place from the equator.

(1) *By means of the Pole Star.*—The latitude of any place in the northern hemisphere can easily be found out by means of the Pole Star. For this experiment you will have to understand the terms 'Horizon.' Go to a place where there are no trees or buildings near about. Look around and you will find that at a certain place the earth and the sky appear to meet and you cannot see anything beyond this arc. This arc where the earth and sky appear to meet and beyond which you cannot see, is called the *Horizon*[1].

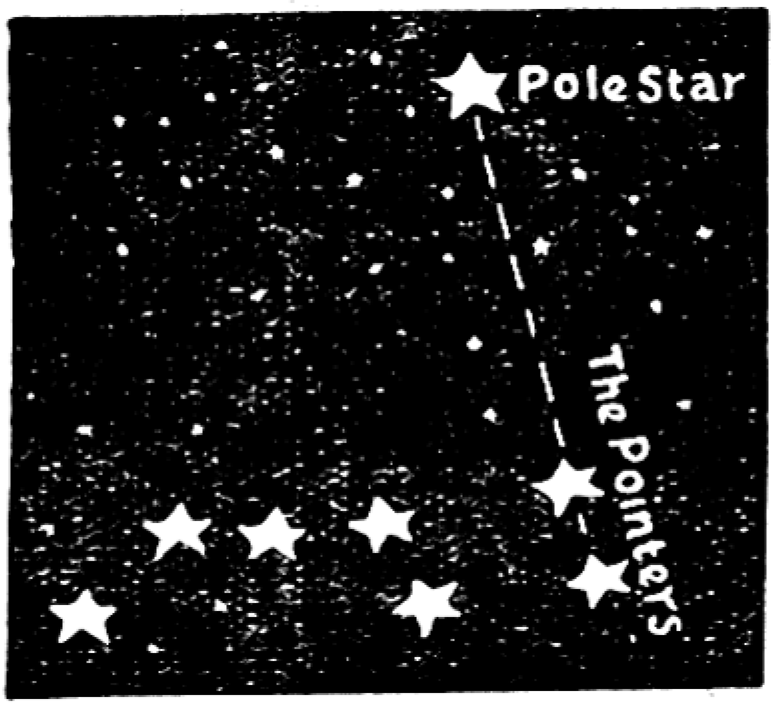

Fig. 17—Pole Star

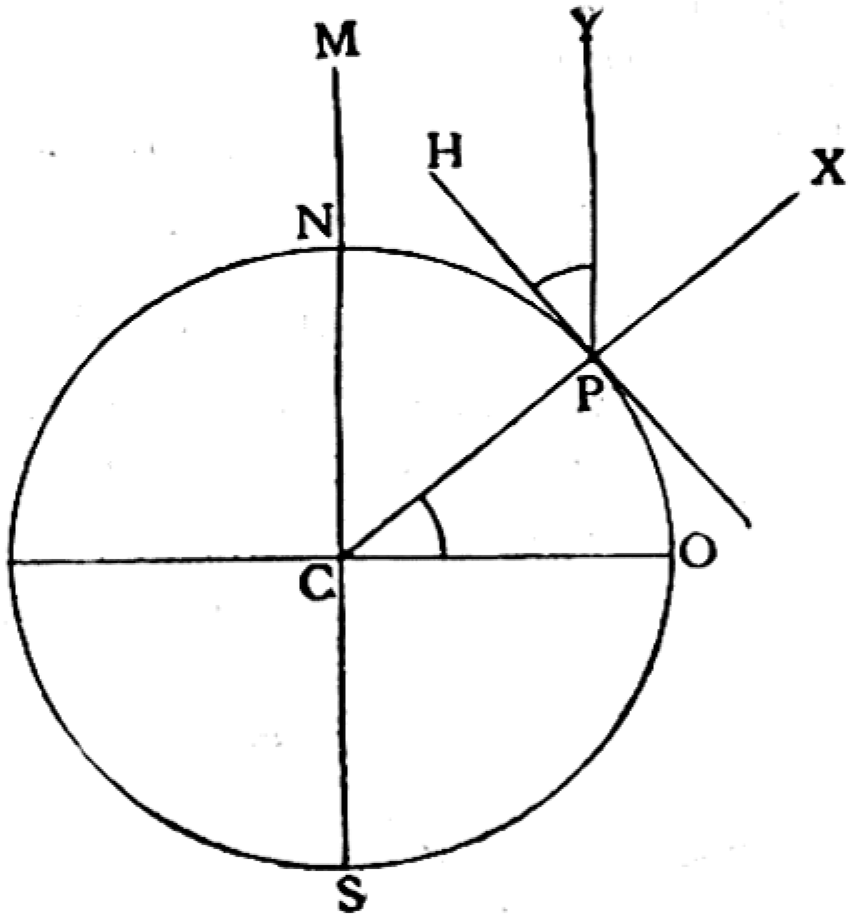

Fig. 18—Finding latitude by means of Pole Star

The latitude of the place P is the same as the altitude of the Pole Star from the Horizon *i.e.*, the angle PCO which represents the latitude is equal to ∠YPH which represents the altitude of the Pole Star. The altitude of the Pole Star could be found out easily with the help of a sextant or theodolite. If you cannot get hold of any of these instruments you can easily do that experiment at home with the help of a thin stick. Fix a piece of cardboard so that it may be level with the horizon. Put a thin stick flat on it. Then raise your stick only at the other point till it points to the Pole Star, then measure the angle made by the stick with the card-board and this angle will be the altitude of the Pole Star as well as the latitude of the place where you are standing.

---

[1] We can see half of the sky, but only a small portion of the earth.

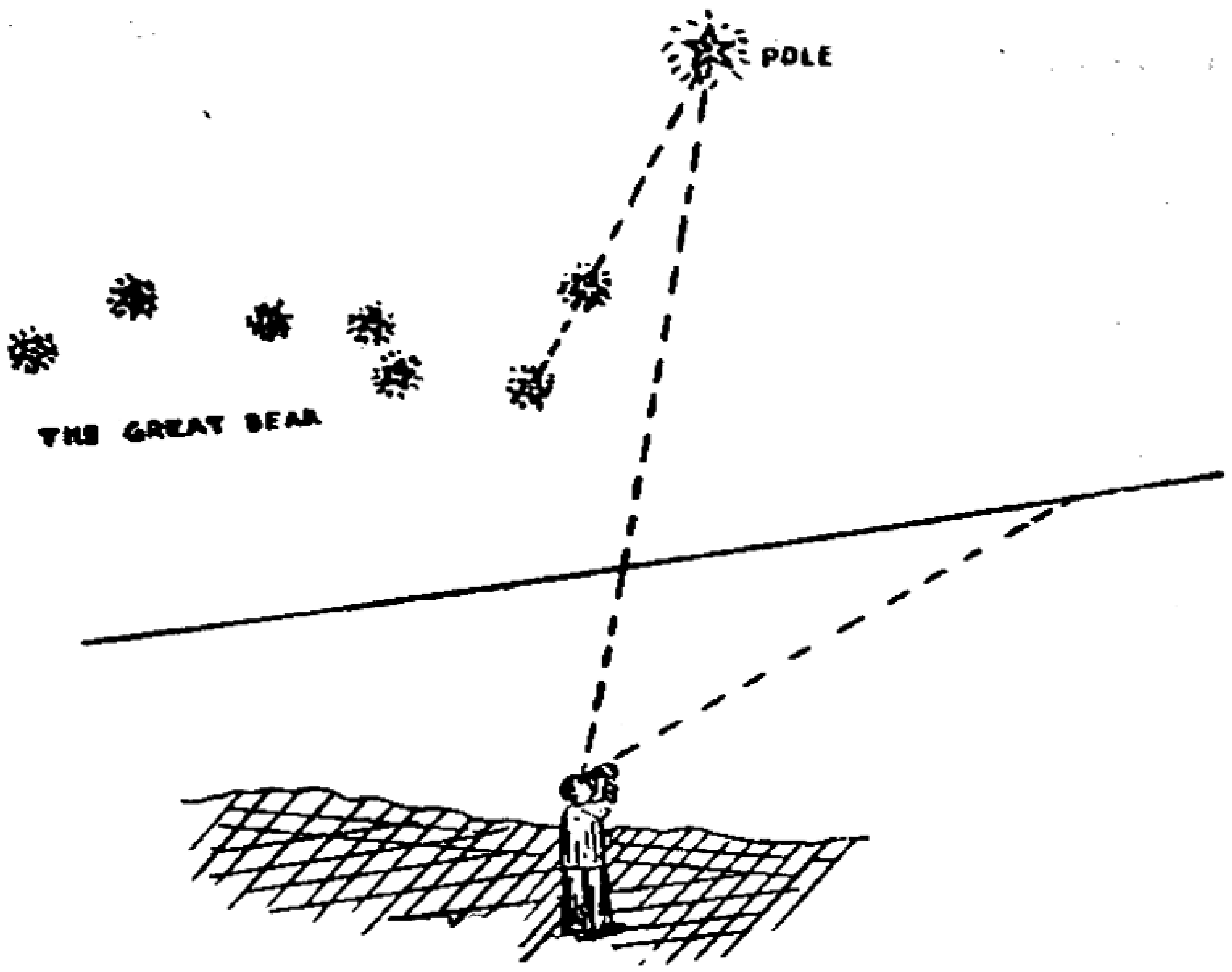

Fig. 19—Measuring the height of the Pole Star

The proof of this is geometrical.

$$\angle NCO = \angle XPH = 90^\circ.$$
$$\angle NCO = \angle NCP + \angle PCO$$
$$\text{and } \angle XPH = \angle XPY + \angle YPH.$$
$$\angle XPY = \angle NCP \text{ being corresponding angles.}$$
$$\therefore \quad \angle YPH = \angle PCO.$$
$$\angle PCO = \text{The latitude of } P.$$
$$\therefore \quad \angle YPH \text{ is also equal to the latitude of } P.$$

This method can be used only in the Northern hemisphere. For finding out the latitude in the Southern hemisphere, some other fixed star will have to be used.

(2) *By means of Mid-day sun.*—You know that on account of the inclination of the axis of the earth, the sun is vertical at the equator only twice during the whole year, *i.e.*, on 21st of March and 23rd of September. On these two days the latitude of any place can be easily found out by measuring the altitude of the mid-

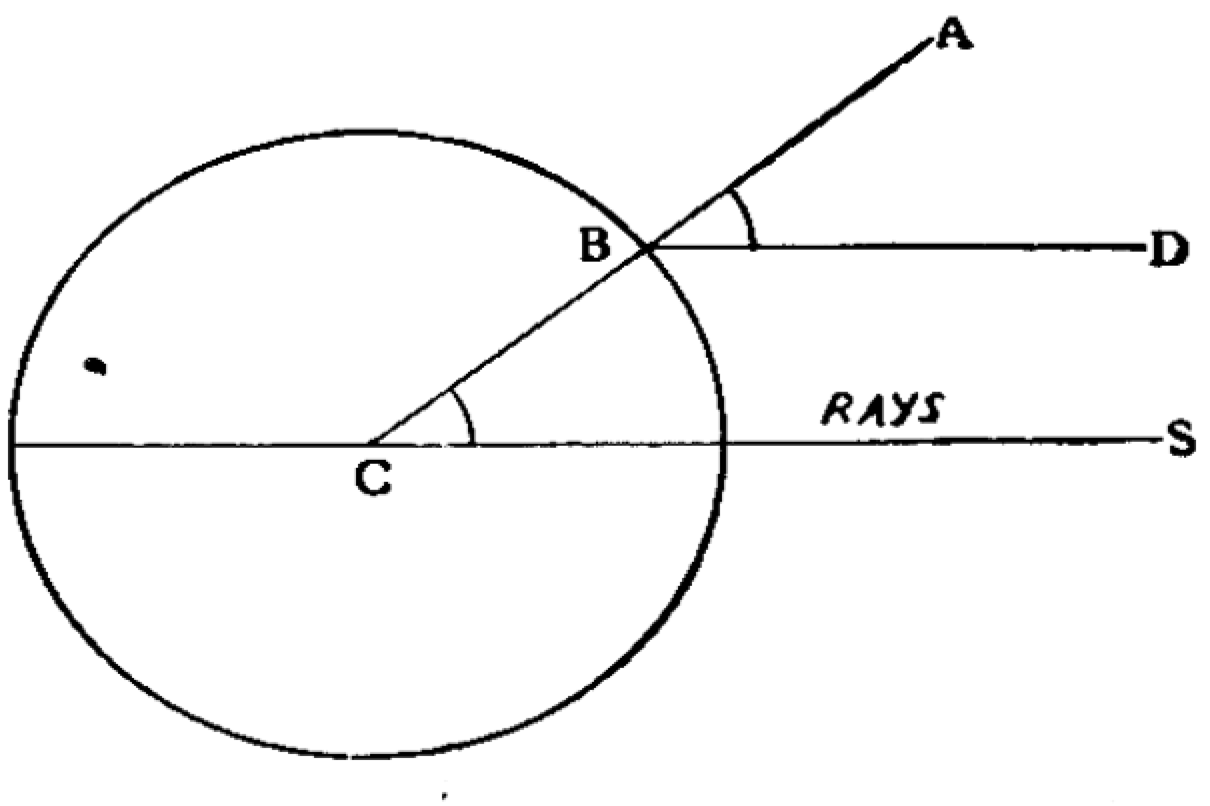

Fig. 20A—Zenith distance is equal to the latitude

day Sun. The Zenith distance will be equal to the latitude of the place. See figure 20A to understand this experiment. Angle ABD represents the difference from the Zenith of the sun at a place called B. Lines BD and CS represent the parallel rays of the sun, therefore, the angle ABD is equal to the corresponding angle BCS. which represents the latitude of B. Therefore the angle ABD is also equal to the latitude of B.

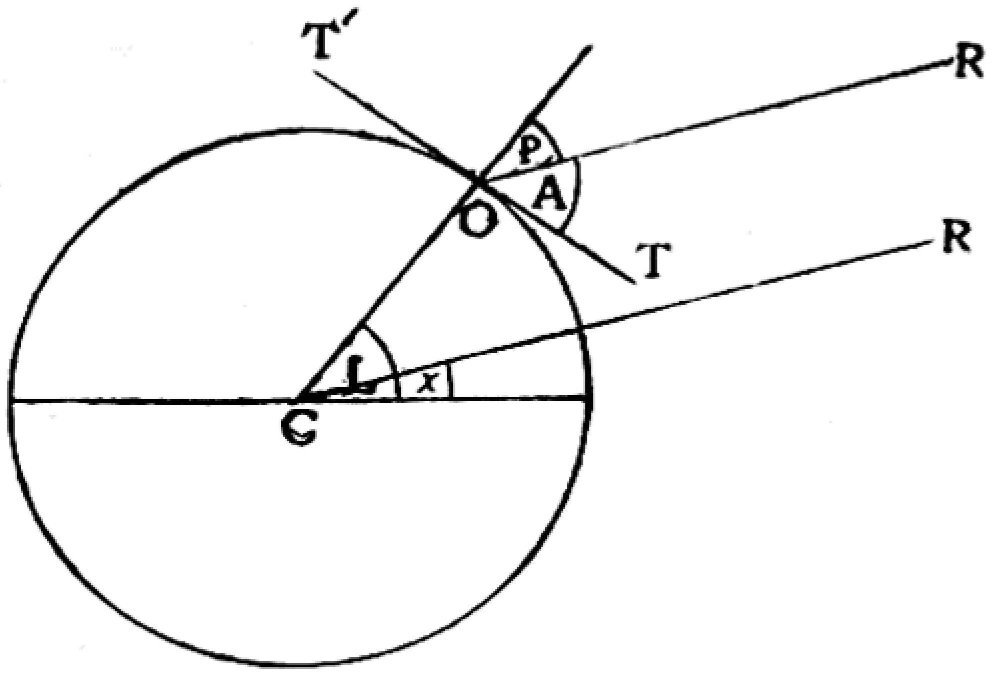

Fig. 20B—When the sun is in the Northern Hemisphere

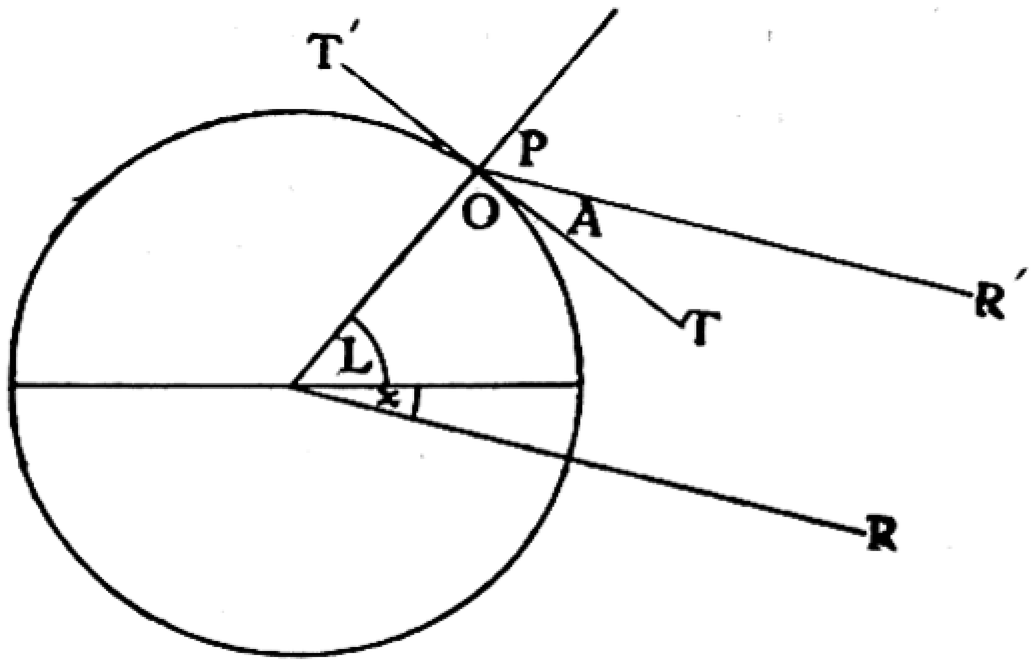

Fig. 20C—When the sun is in the Southern Hemisphere

The difference of the sun from Zenith is called ‘ Zenith distance.’ It is found out by subtracting the height of the sun from 90 degrees.

The figures 20-B and 20-C show how we can find out latitude on other days. With the help of the Nautical Almanac, the exact position of the sun is found and proper adjustments made for the degree of latitude where the sun is vertically overhead.

(*g*) **Determining Longitude.**—We all know that the earth rotates round its axis, that it takes twenty-four hours to make a full turn, *i.e.*, 360 meridians of longitude take full twenty-four hours to pass under the sun. We also know that the earth rotates from west to east, therefore, the eastern meridians come in front of the sun before the western meridians. By calculation we find that fifteen degrees of longitude pass under the sun every hour and that one degree passes under the sun in four minutes.

Study figure 21 and you will understand the truth of the above statement. It should be also be told that all the places on the same meridian pass under the sun at the same time. When the meridian of longitude of a certain place comes just in front of the sun it is morning or dawn there; when it passes directly under the sun it is noon; and when it is about to go away into darkness again it is sunset or evening.

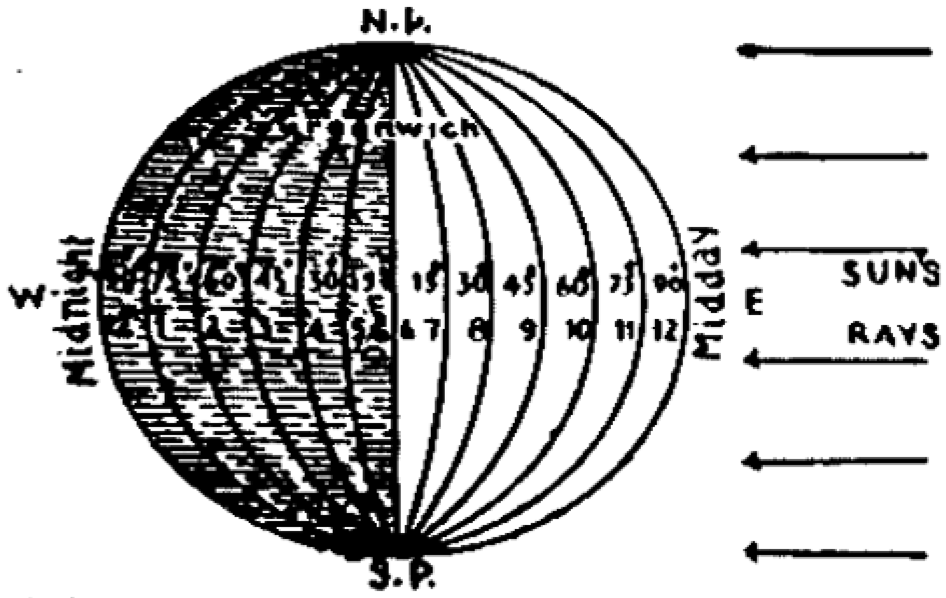

Fig. 21—Longitude and time

From what has been said above it must be quite apparent by now that there is a close relation between longitude and time. Study the given diagram again before proceeding further. It is very easy now to find out the time if we know the longitude. Suppose we have to find out the time at a certain place X situated 37 degree east when it is noon at Greenwich.

For every 1 degree the difference in time = 4 minutes.

For 37 degree the difference in time = 4 × 37 minutes.
= 148 minutes.
= 2 hours 28 minutes

Since X is East of Greenwich the time will be ahead of Greenwich *i.e.*, 2·28 p.m.

If a place is situated West of Greenwhich the time there will be behind the Greenwich time.

In the same way if we know the time we can work out *longitude* of places. Below are given a few exercises for practice:

(1) When it is noon at Greenwich it is 5.31 a.m. at Winnipeg. Find out its longitude.

(2) What will be the time at Calcutta when it is 7 a.m. at Aden?

(3) Find out the difference in time between Bombay and New York.

(*h*) **The problem of Time.**—Every place has its own longitude, therefore, it also has its own time which is different from places situated on other meridians. This time is the *local time* of that place The local time of all places on one meridian is the same.

Every meridian has its own local time but it would be very inconvenient if every place kept its own local time because then we will constantly be playing with our watches as we move. If a man travels from Agra to Lucknow either he will have to put his watch ahead after every degree of longitude or on his arrival at Lucknow he will find that his watch is very slow.

In order to remove this difficulty and to facilitate the running of railways etc. a country generally follows only one time. This is called *Standard Time.* Generally the practice followed is that the central meridian is taken as the standard. In India the local time of 82½ degrees East meridian is taken as the standard. Indian standard time is 5½ hours ahead of Greenwich time.

Time Zones.—In order to facilitate international, commercial and political intercourse, the world has been divided into time zones where one standard time is maintained. This is called *zone time.* At present there are the following time zones.—

Countries	Difference from Greenwich time	Central Meridian
The British Isles, France, Belgium, Holland, Spain, Portugal, Algeria, (West European time).	None	
Germany, Italy, Switzerland, Denmark, Norway, Sweden, Austria, Czechoslovakia, Hungry, Yugoslavia, Albania, Angola, S. W. Africa, Tunis, Belgiun, Congo (Mid. European time)	1 hour ahead	15-E
Russia, Roumania, Bulgaria, Turkey, Greece Egypt, Anglo-Egyptian Sudan, Uganda, Kenya, South Africa (East European Time)	2 hours ahead	30-E
Mauritius	4 hours ahead	60-E
India, Ceylon (Indian-Standard Time)	5½ hours ahead	82½-E
Burma	6½ hours ahead	97½-E
Straits Settlements	7 hours ahead	105-E
Hongkong, Borneo, West Australia	8 hour ahead	120-E
Japan and Koria	9 hours ahead	135-E

Countries	Difference from Greenwich time	Central Meridian
South Australia	9½ hours ahead	142½-E
Eastern Australian States	10 hours ahead	150-E
New Zealand	11½ hours ahead	172½-E
America, Brazil, East Coast or Atlantic	3 hours behind	45-W
Inter-Colonial (Halifax)	4 hours behind	60-W
Argentina, Brazil, interior Eastern (New York)	5 hours behind	75-W
Central (St. Louis), Panama to South Chile in South America.	6 hours behind	90-W
Mountain (Denver)	7 hours behind	105-W
Pacific (San Francisco)	8 hours behind	120-W

The International Date Line.—It has been said before that if we go to the east of the prime meridian, we gain time at the rate of 4 minutes per degree and if we go west of the prime meridian we lose time at the same rate. If two travellers start from the prime meridian at the same time, one going to the west, and the other to the east when they will meet at 180° longitude the eastward traveller will have gained twelve hours and the westward traveller would have lost twelve hours, *i.e.*, according to

e Kapoor on page 17

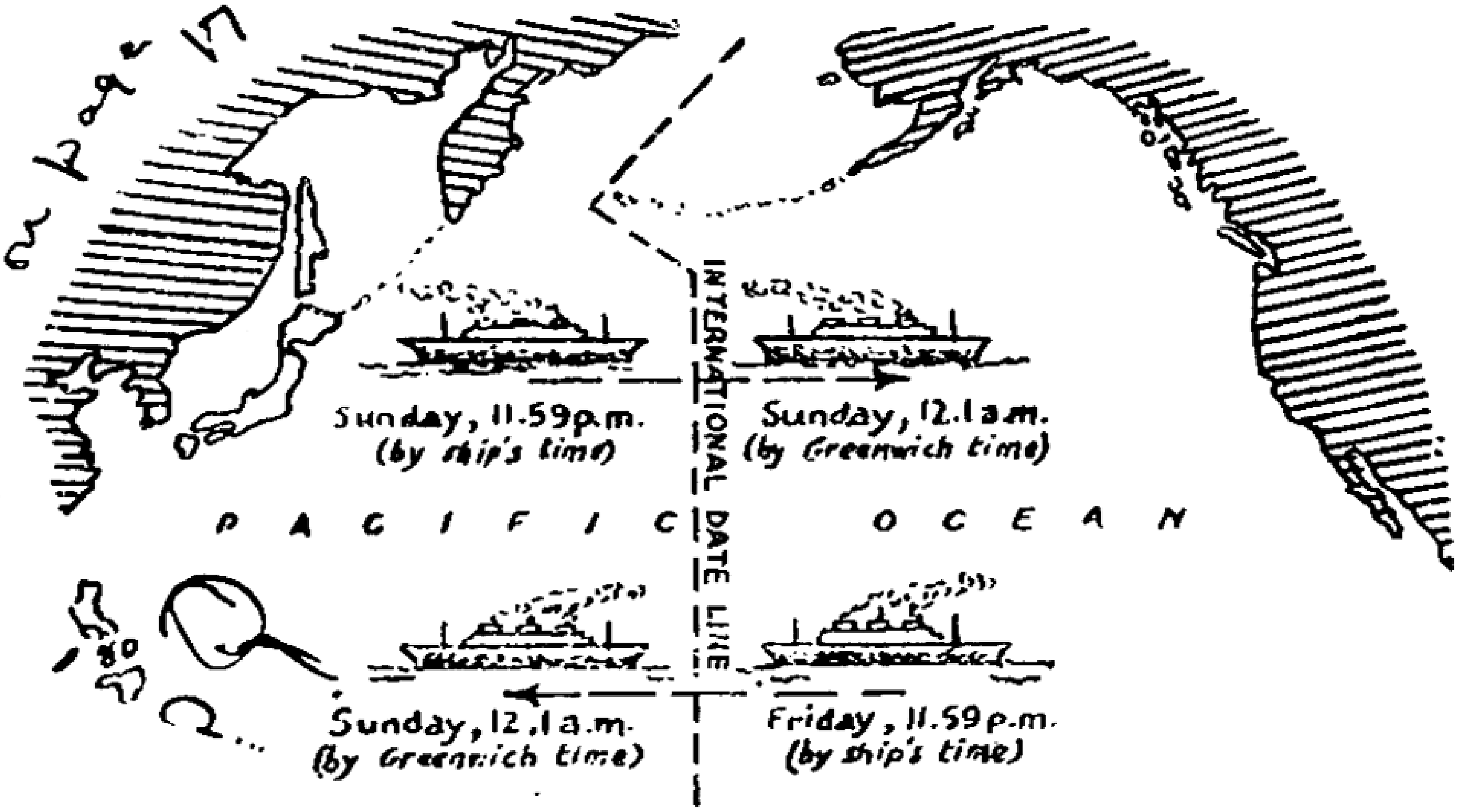

Fig. 22—The International Date Line

their watches the difference between their time will be one day, *i.e.*, 24 hours. The eastward traveller would be 24 hours ahead of the westward traveller. To overcome the confusion that has arisen the *international date-line* has been instituted at 180° (Fig. 22). The traveller who has gained one day drops one day and the other traveller who has lost one day adds a day to his time as soon as they the cross this line. The meridian 180° was selected for this purpose because it passes through the middle of the Pacific Ocean, where on account of small amount of land, the sudden change in date causes little inconvenience. As you will see from the diagram the line does not always keep its position exactly on the 180° meridian. This is done to avoid its cutting throngh small groups of islands, so as not to disturb their time.

(*g*) **Directions.**—In order to find our way in this world we have to be sure of the directions. It is easier to find them in an atlas map where this is very simply illustrated by means of an arrow pointing north ; or simpler still, the top of the map indicates the North in the map, the bottom South, the rest is easy to find out. But this method is applicable only on a map.

In our lower classes, we were told that we can easily find out the four directions *i.e.*, North, South, East, and West by facing the rising sun in the East. But at this stage, we require something more scientific and accurate. Below are discussed some of the more important methods.

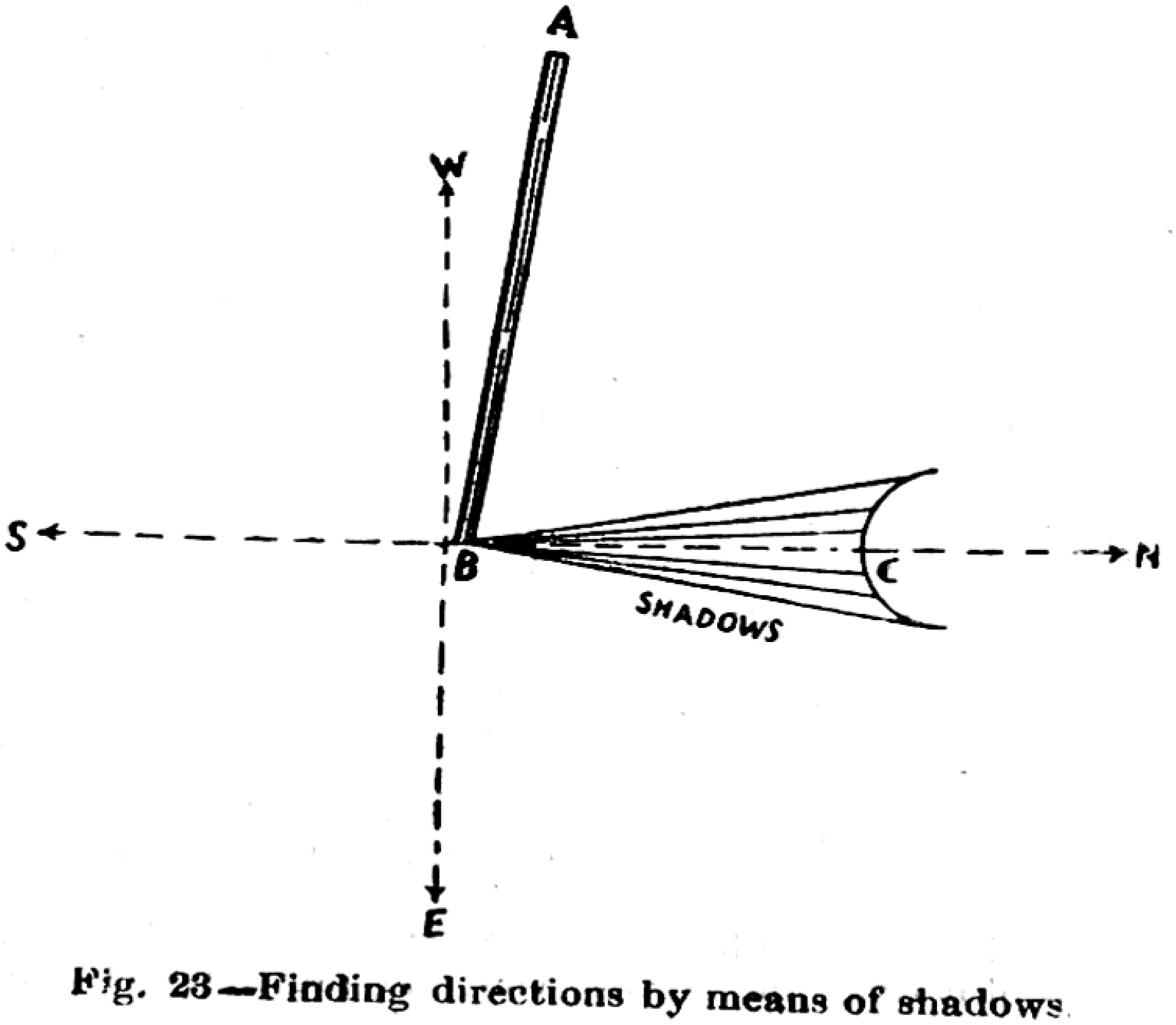

Fig. 23—Finding directions by means of shadows

(*a*) **By shadows.**—An approximate N. S. line can be had by observing the shadows cast by the sun. The shadows are shortest when the sun is highest in the heavens. In the northern hemisphere it is due South beyond the Tropic of Cancer. For its position between the Tropic of Cancer and the equator, we must know about the date etc. In northern India, therefore, if we find out the position of the shortest shadow, we shall have a true north and south line. This can be done easily by erecting a pole in an open place and measuring the shadows. It will be noticed that as noon approaches, the shadows get shorter and shorter, and when the sun has passed the highest point in heaven, the shadow begins getting longer. A line at right angles to this line shall point true east and west (Fig. 23).

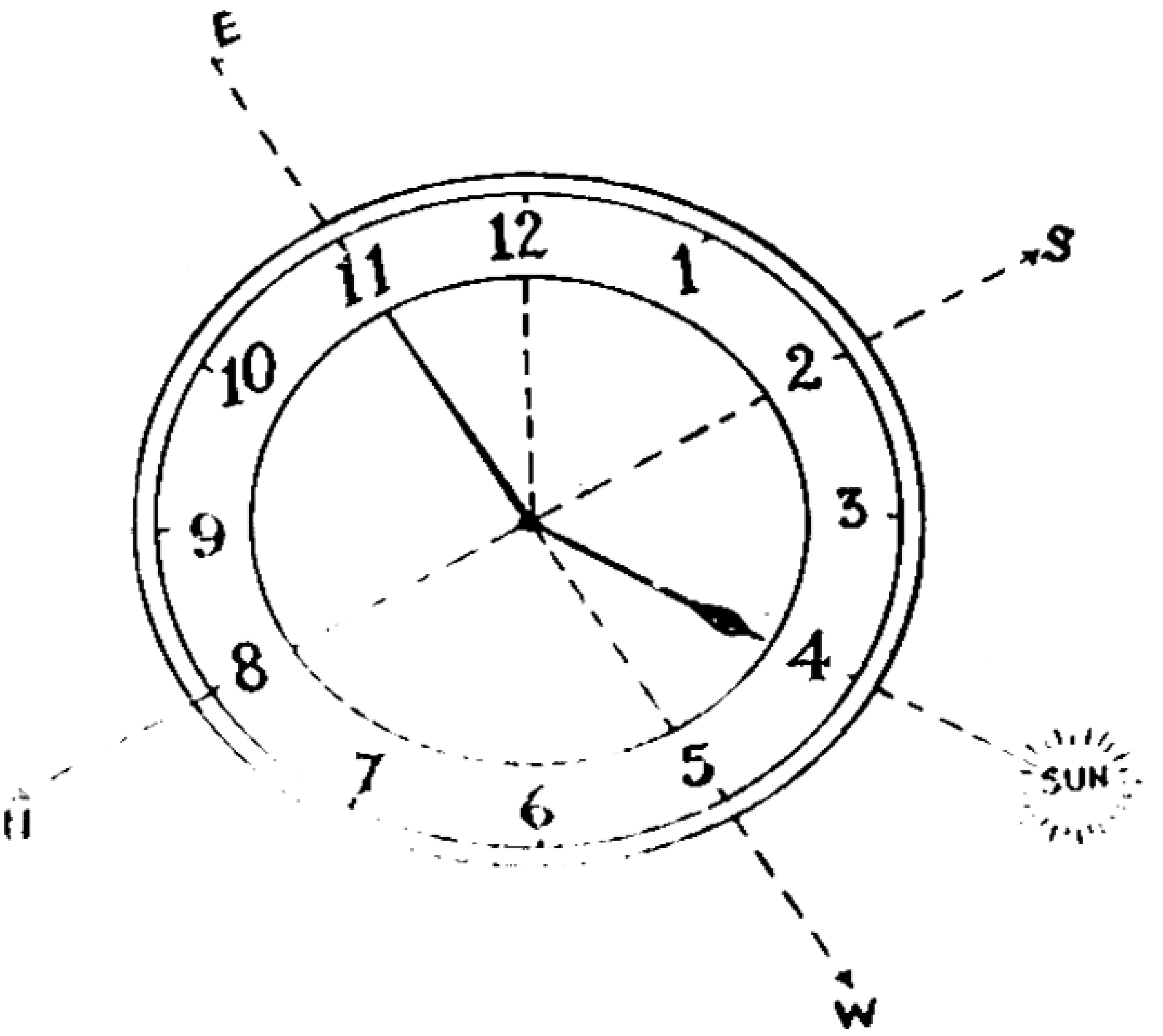

Fig. 24 – Finding directions by means of a watch

(*b*) **By a watch.**—Point the hour hand of the watch towards the sun by putting the watch on your palm and turning it round accordingly. The south-north line bisects the angle made by the hour hand and the line joining 12 on the watch with the centre of the dial (Fig. 24). This method is, however, applicable only in the northern hemisphere and is more dependable in the higher latitudes.

(*c*) **By means of the pole star.**—At night we can find out the directions from the Pole Star which is always in the North. It has been explained elsewhere in this book how the pole star can be found out in the sky. Study (figure 17). All stars go round the pole star once every twenty-four hours but their relative positions remain the same. But you should not forget that the pole star is visible only in the northern hemisphere and this method is applicable only there.

(*d*) **By compass**[1].—Modern life demands that we should have some instrument to find out the directions at all hours of the day, in all conditions of weather and in all places on the earth. The invention of the *magnetic compass* (Fig. 25) whose needle always points to the North has been of tremendous use to sailors, pilots and the laymen alike.

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[1] It is said that the Chinese were the first to invent it. Europe came to know of it from the Arabs who had previously learnt of it

The north pointed out by the compass (Magnetic North) does not exactly coincide with the true North or the Sun North (Fig. 26). The variation of the compass or the Magnetic declination as shown in the figure varies all over the world and from year to year[2].

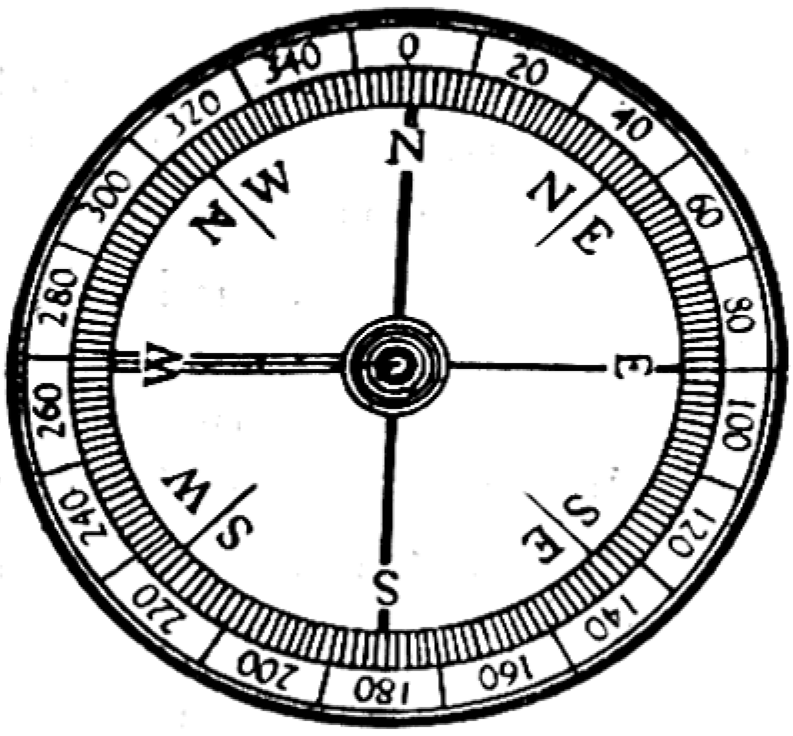

Fig. 25—Directions on a compass

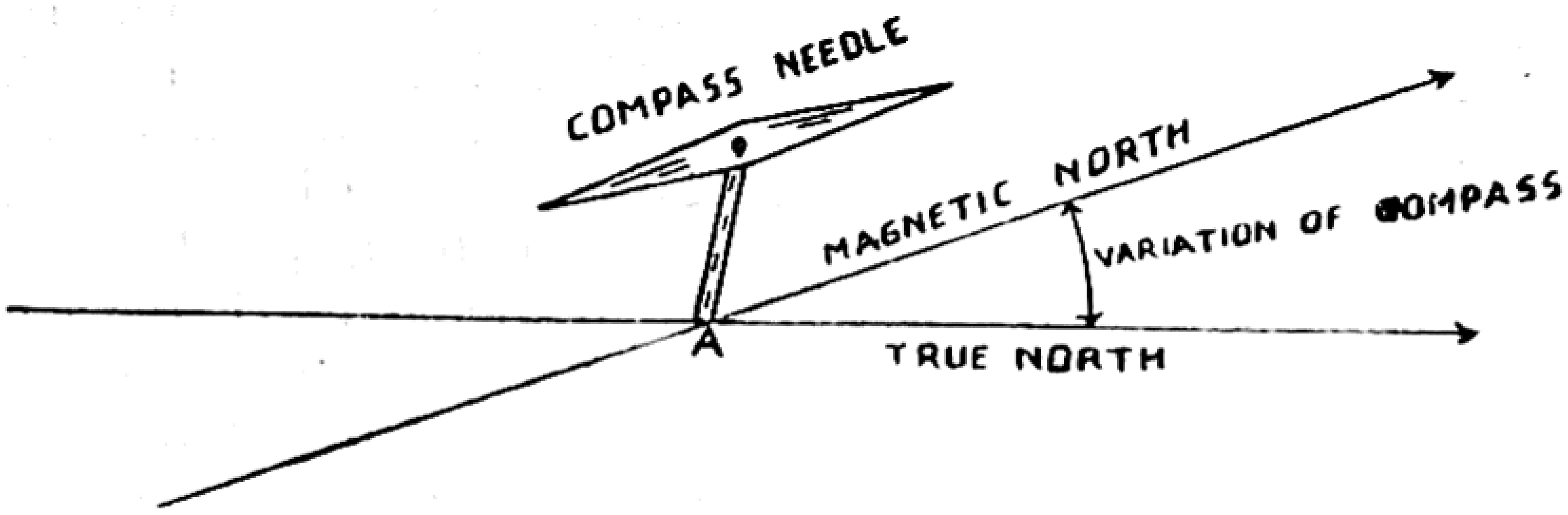

Fig. 26—Magnetic and True North

SECTION C.

THE EARTH AS A PLANET

(a) Movements of the Earth.—The earth rotates on its axis from West to East thus giving us a succession of day and night every twenty-four hours (Fig. 27). It also revolves round the sun once in 365¼ days or one year[3]. The path followed by it in its annual movement round the sun is called the earth's '*orbit*.' This orbit is not a

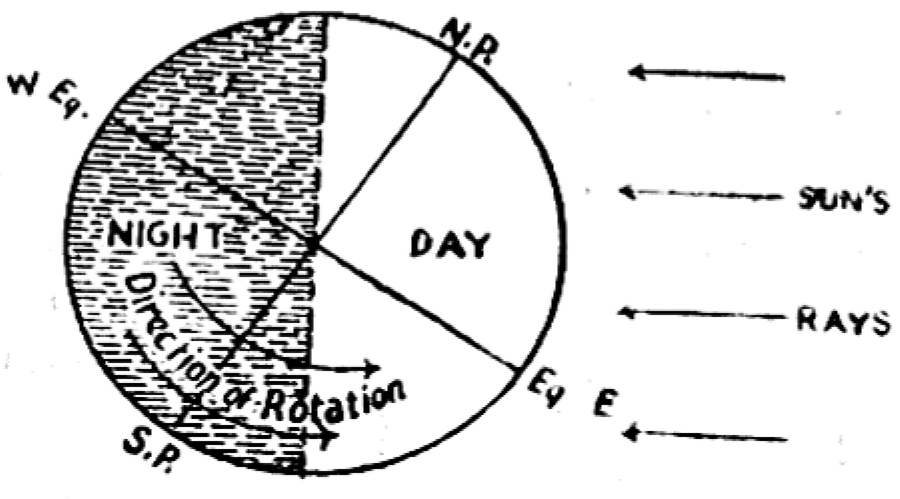

Fig. 27—Rotation of the Earth

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from the Chinese. It was invented sometime in the14th century. The modern compass is a greatly improved and developed form of the original specimen.

[2] In England in 1913 the compass pointed to a direction 16° West of North but in 1931 this declination was only 13° West.

[3] A year has only 365 days. The ¼th day is added up and every fourth year a day is added *i.e.*, that year has 366 days (Leap year)—

circle but takes the shape of an ellipse as has been explained before.

The plane that includes the path of the earth around the sun and also passes throuh the centre of the earth and the centre of the sun is termed as the *plane of the earth's orbit.*

(*b*) **Earth's axis.**—The earth's axis is inclined by 23½° from a perpendicular to the plane of its orbit. The axis always points to the same part of the heaven—the north and towards the North Star.

?
66

(*c*) **Rotation.**—How do we know that the earth rotates? The simplest answer is because the sun, moon and the stars rise and set, days and nights are caused and this can only happen if the earth rotates. This was proved for the first time by Capernicous and Galileo. However, the most convincing proof is the course of a ball dropped from a great height. It does not strike the earth at the point and towards which the plumb line* is directed but a bit more to the east. This is due to the fact that during the short time the ball takes in reaching the earth, both the ball and the earth have rotated to the east. The ball falls perfectly straight, but because it starts from a point outside the earth's surface, it has an eastward motion greater than that of the point on the surface below it. The rate of deviation is one inch for every 500′ of fall in middle latitudes. The rotation can also be demonstrated by the gradual changes in the direction of the swing (Faucault carried out this experiment for the 1st time) of a pendulum (Fig. 28).

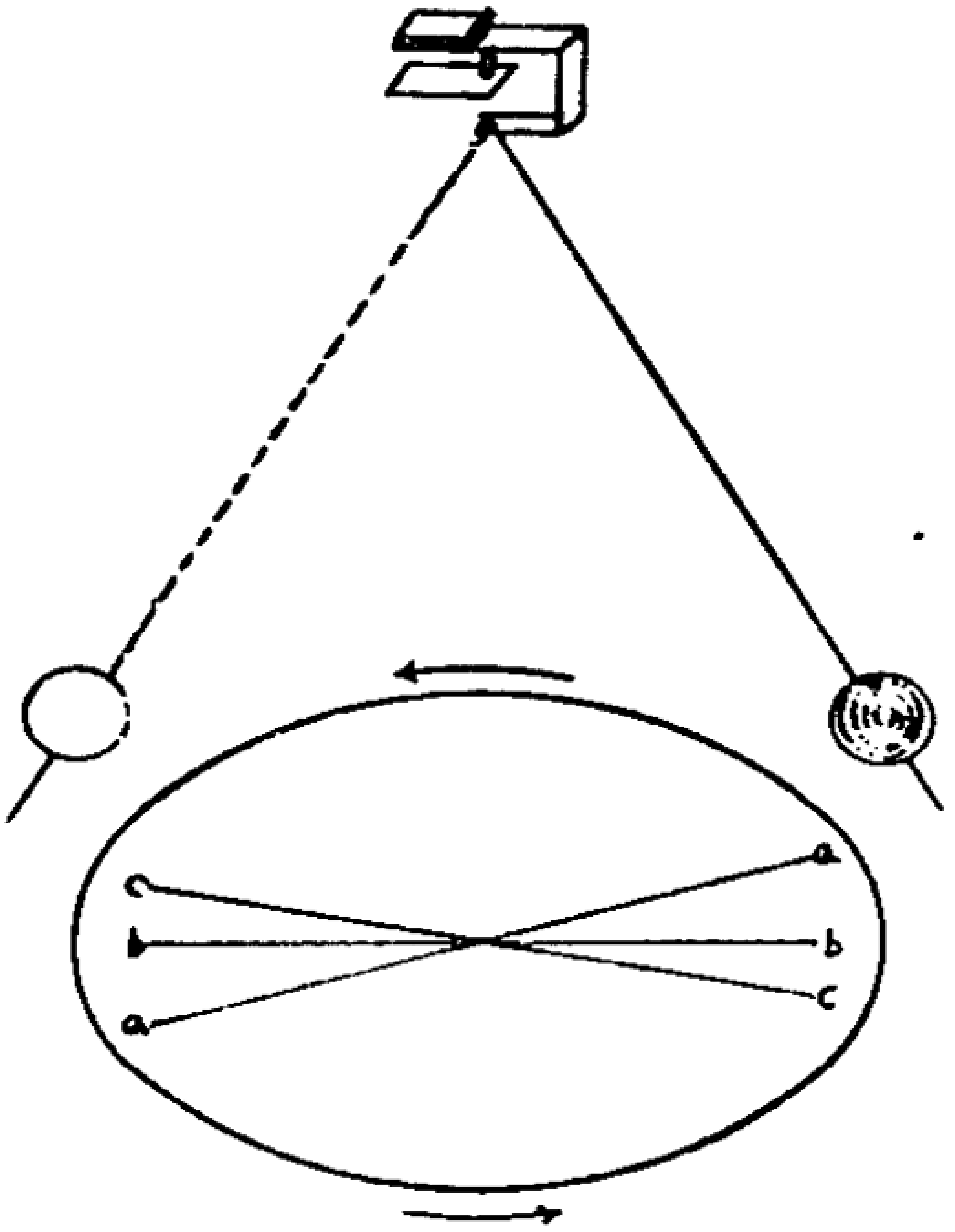

Fig. 28—Faucault's Experiment

(*d*) **Consequences of the earth's movements.**—(1) The rotation of the earth on its axis causes days and

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Febrnary having 29 days instead of 28.

*" Barring a slight deflection due to the varying density of different parts of the earth, a plumb line suspended from a lofty structure such as the Eiffel Tower in Paris, points straight towards the earth's centre."

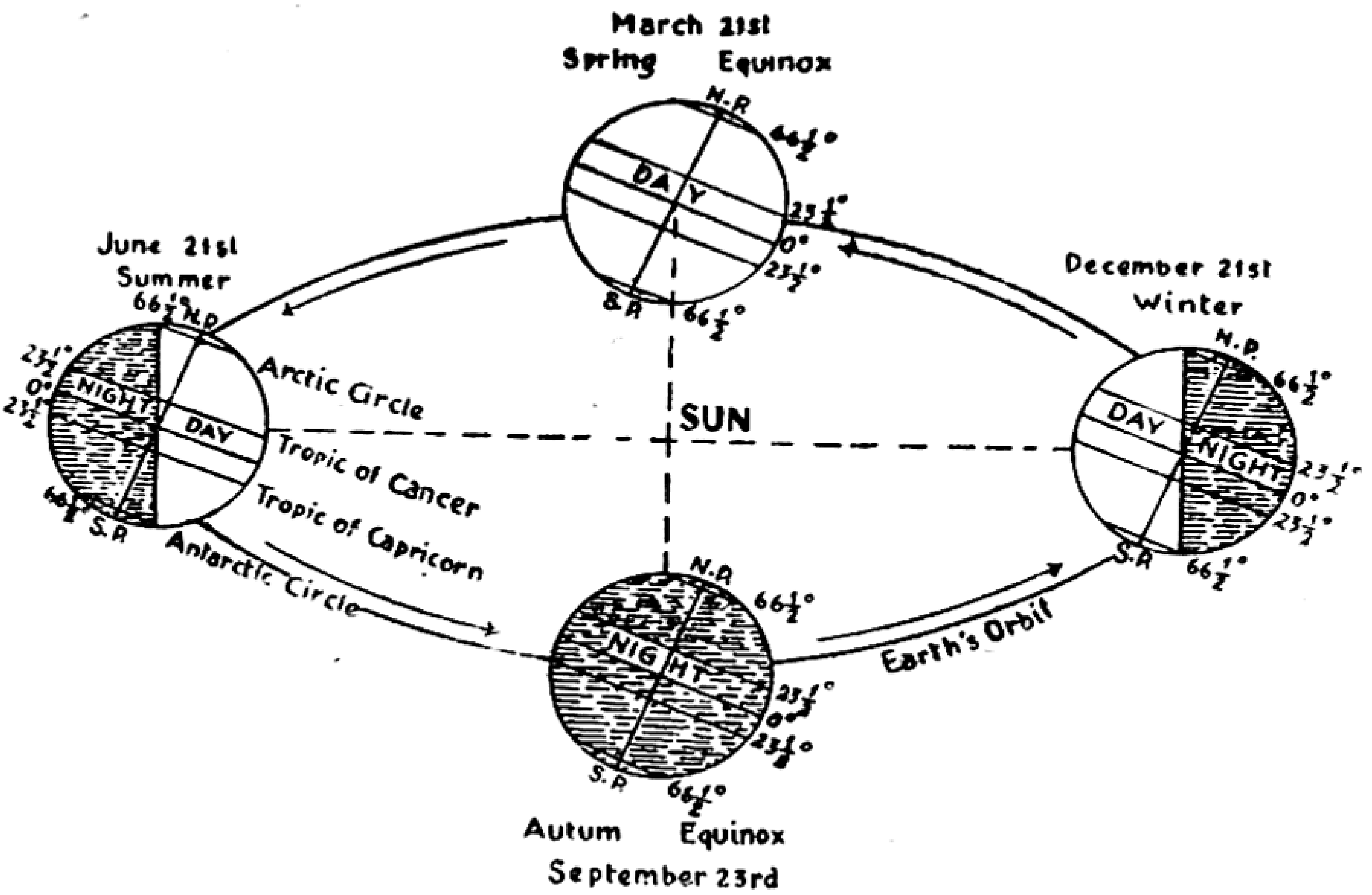

Fig. 29—Showing the four positions of the earth

nights. The earth being a globe, only half of it can be lighted at a time by the sun. Because the earth rotates every portion remains for sometime in light and for the rest in darkness. The period for which a place remains before the sun is called 'day' and the period during which it remains in darkness is called 'night.' The total length of day and night is equal to 24 hours during which period the earth completes one rotation.

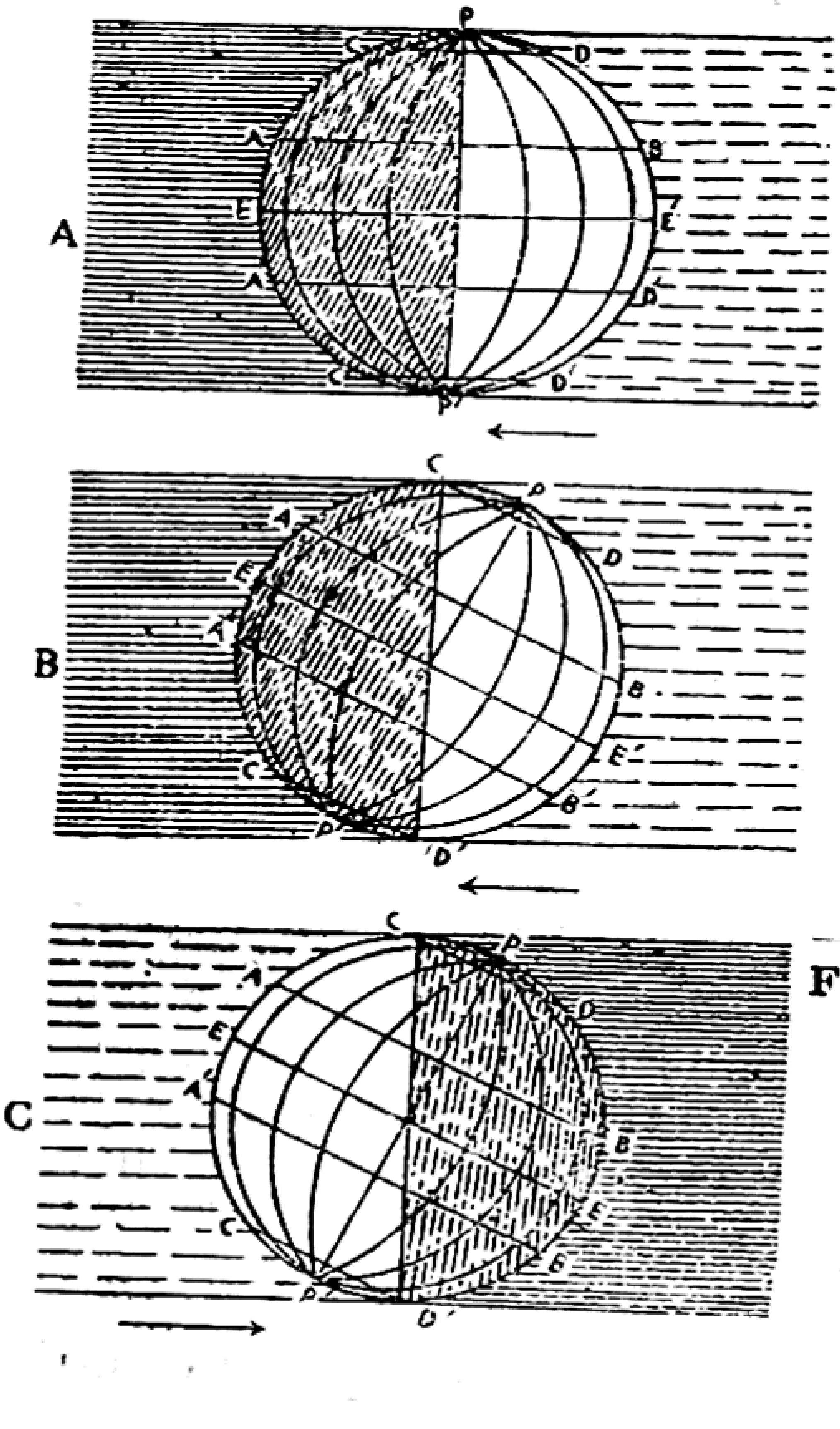

Fig. 30—Position A shows equal days and nights. Positions B shows the longest day in the Northern Hemisphere; and Position C shows the longest day in the Southern. It however, goes without saying that longest days are accompanied by shortest nights.

(2) The earth rotates as well as revolves, and its axis is inclined by 23½°. These cause unequal days and nights and seasons. Study Fig. 29. where the four positions of the earth have been shown and in every place the lengths of days and nights are different. Fig. 30 shows very much the same thing in a better manner. Figure 31 shows the monthly positions of the earth and there also you will notice that the lengths of days and nights are varying. Twice a year *i,e.* on March 21 and September 23 the earth is in such a position that the sun is overhead at the equator and consequently the days and nights are equal all the world over—hence the term Equinox (The September position is called the 'Autum Equinox' and the March position 'Spring Equinox'). On the 21st of June, the sun is overhead at 23½° N. (Tropic of Cancer) and consequently on this day the 'day' is the longest in the Northern hemisphere and the shortest in the Southern hemisphere. The opposite of this happens on the 22nd of December when the sun is overhead at 23½° S. (Tropic of Capricorn). These movements are called Solstices. It is only at the equator that days and nights are always equal. It is because the equator is the only parallel of latitude which is always bisected by the line separating day from night. The two poles have days and nights of 6 months' duration.

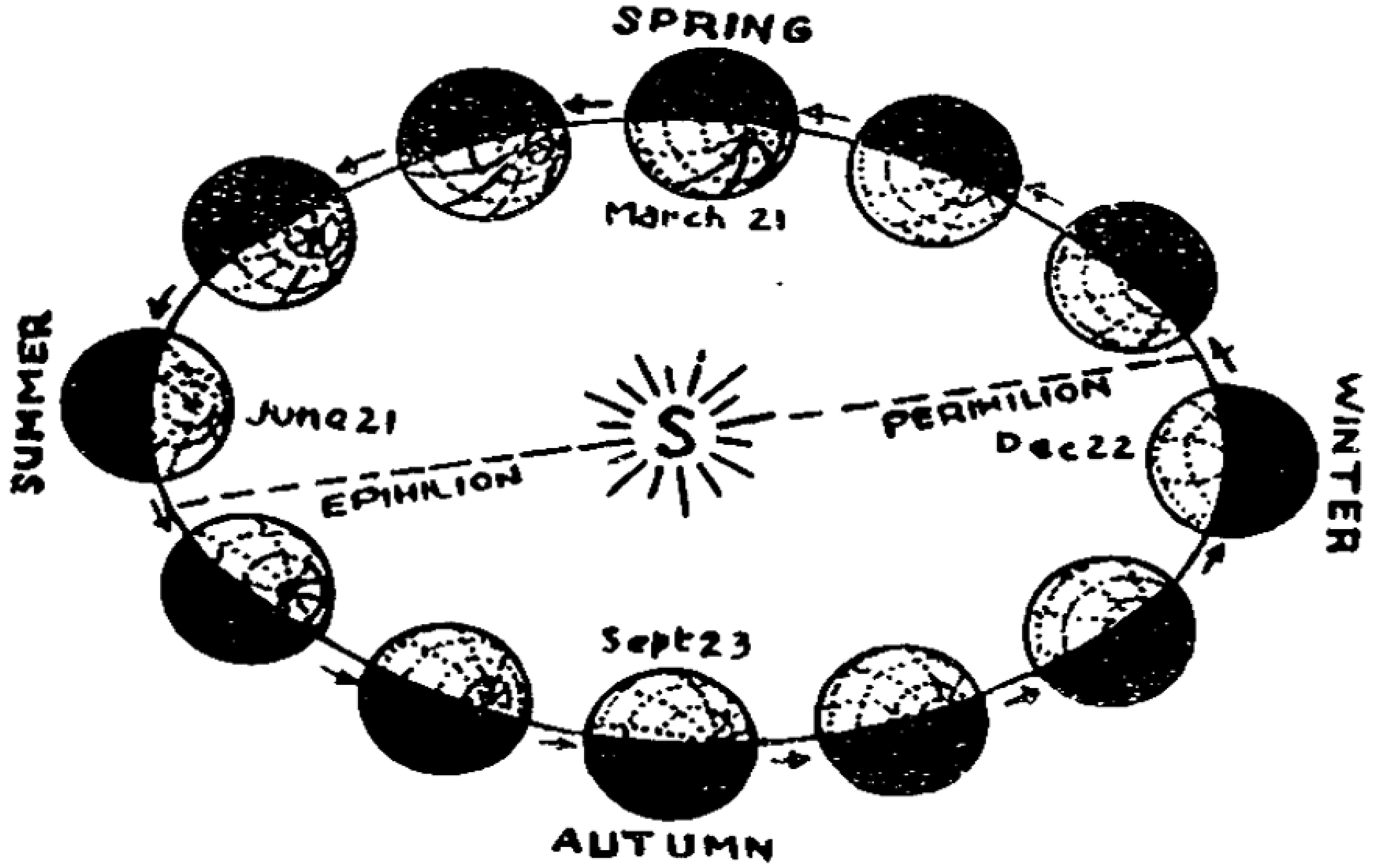

Fig. 31—Monthly positions of the earth in relation to the sun

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The maximum and minimum lengths of days and nights respectively are detailed below :—

Degrees of latitude	Longest day	Shortest night
0	12 hrs.	12 hrs.
	H. M.	H. M.
20	13—12	10—48
30	13—50	10—10
40	14—52	9—8
50	16—18	7—42
66½	24—0	0—0

In 70′, 80′, 90′, of latitudes the maximum length of days is 2 months, 4½ months and 6 months respectively.

A study of figure 31 will show that within the Arctic and the Antarctic circles, there are places where there is continous light for a long time. At the two circles the days on the 21st of June and 22nd of December are of 24 hours' duration respectively. This phenomenon is often referred to is as the *mid-night sun.*

The unequal days and nights also affect the temprature conditions in the two hemispheres. When the days are longer in one hemisphere it is *summer* there and when the nights are longer, it is *winter.* The seasons are, therefore, due to the variations in the earth's positions caused by the revolution and also to the inclination of the axis of the earth that causes unequal days and nights.

SECTION D

EARTH AND THE MOON.

The moon is the body nearest us. It is so near us that it could be bridged over by 30 earths. A telegram could reach there in a few seconds. The actual distance between the two bodies is about 240,000 miles. Its diameter is about 2,160 miles. Like the earth it also rotates on its own axis.

The moon goes round the earth in about 27⅓ days and this period is called the 'Siderial Month.' It also has an eastward movement with the sun, hence it appears to lag behind in its revolution round the earth by about 2½ days in one complete round and is consequently, seen to rise 50 minutes later every night and moves to an eastward position. On account of this eastward movement it takes more than 27⅓ days to make one complete round of the earth—this period is called the 'Synodic month.' The 'Lunar month' is the mean between the 'Siderial' and the 'Synodic' months. A year has 13 'Lunar months.'

The path on which the moon goes round the earth (Moon’s Orbit) is the shape of an ellipse and the earth is not exactly in its centre. When the moon is farthest from the earth, it is said to be in ‘Apogee position,’ and when it is nearest it is in ‘ Perigee position ; when the sun, moon and the earth lie in one line, the moon being in the middle, the moon is said to be in ‘ conjunction ’ with the sun. When the earth is in the middle and the moon is on the farthest end, it (*i.e.*, the Moon) is said to be in ‘ opposition ’ with the sun. And lastly when it is in line with the earth it is said to be in ‘Quadrature.’ Figure 32 shows the various positions detailed above.

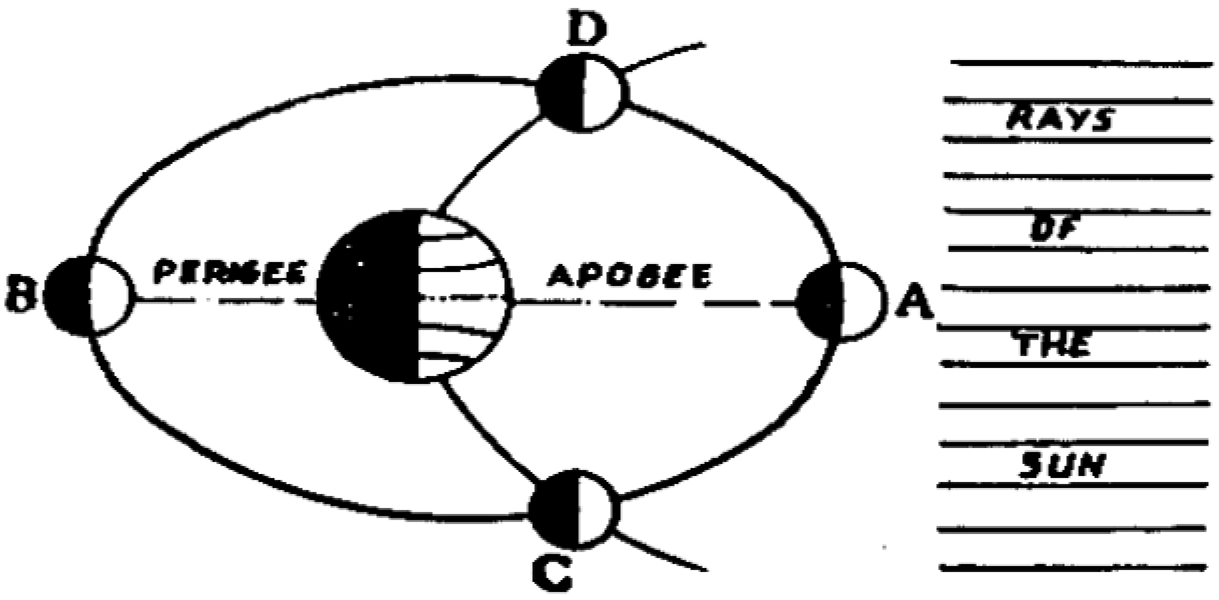


Fig. 32—The positions of the Moon

The plane of the moon’s revolution round the Earth makes an angle of 5 degrees with that of the earth round the sun. Had it not been so, the sun’s light would have been cut off by the moon at every new moon and that of the moon by the Sun at every full Moon ; though the cutting would not at all time be complete, because if the moon came between at a time when the distance between the sun and the moon is greater than it commonly is, the shades sent out by the moon would not be great enough ; and the complete body of the sun would not be covered by it. Round the dark body of the moon in front of the sun, we would see the edge of the sun in the form of a ring of light.

As the moon is a sphere, one half of it is always in dark. We see only half of the moon and that is the maximum we can see of it at the time of the full moon. The moon, however, goes through the regular ‘ phases ’ shown in fig. 33, in a period of about twenty-nine and a half days due to its relative position with the earth and the sun. The new moon is first seen in the western sky as a thin crescent. The crescent gradually grows wider. At the time of new moon, the moon is between the sun and the Earth, all the three being practically in a straight line. At the time of full moon, the moon is on the opposite side of the earth from the sun. When the moon is in its first and third quarters its direction from the Earth is at right angles to that of the sun. Why we do not have a total eclipse of the sun at the time of the new moon has been explained before. As is clear from the figure, during one revolution round the earth that is in about thirty days, the new moon grows to a full moon and then again dwindles to zero, being quite invisible for some time (3 days) till it appears again.

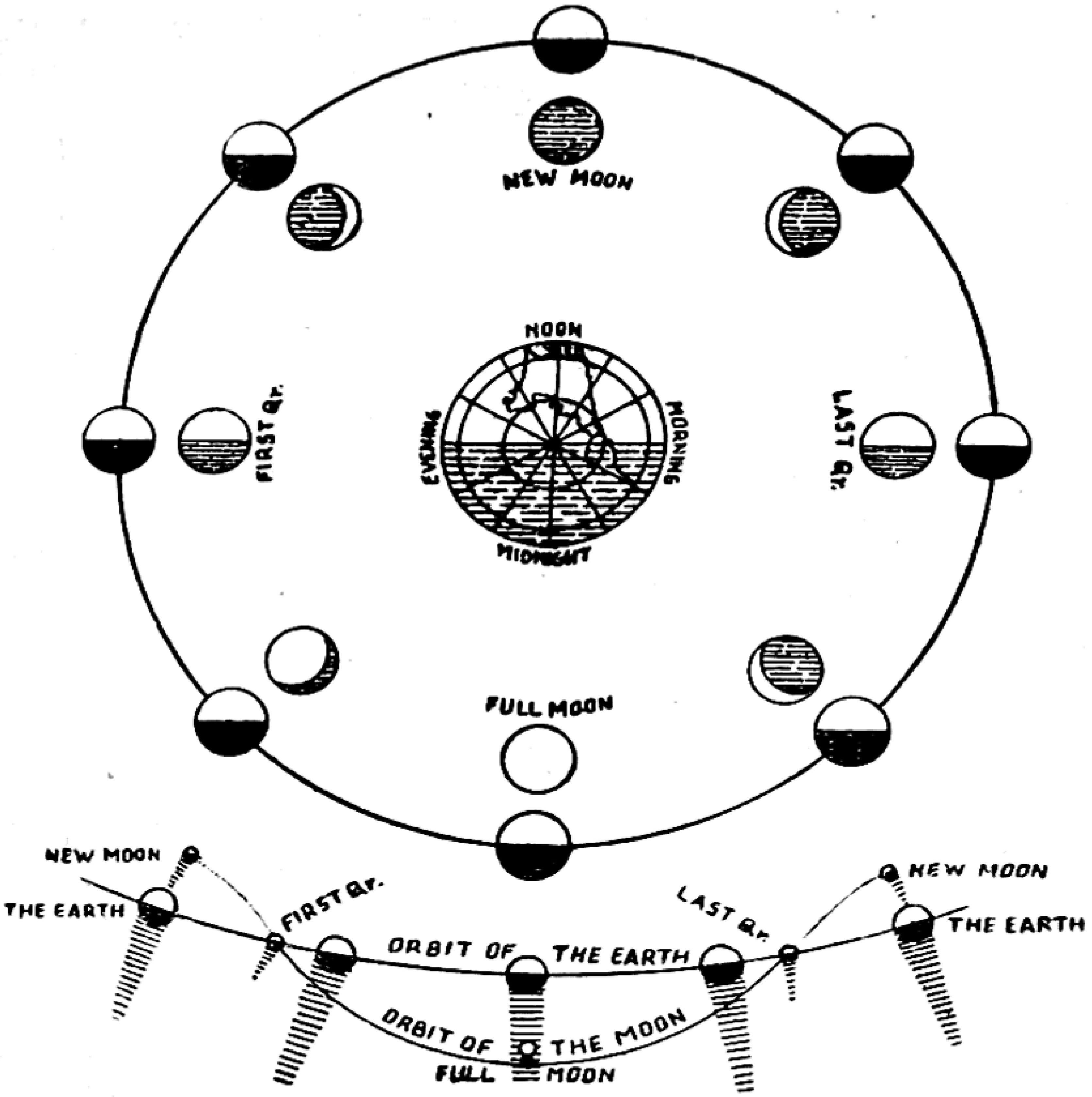


Fig. 33—The phases of the moon (after Goodall)

The Eclipses.—Sometimes the earth passes exactly or almost exactly between the moon and the sun, thus preventing direct sunlight from reaching the moon ; hence we cannot see the moon during the short period it passes through the earth's shadow. This is called a 'lunar eclipse.' During a lunar eclipse, the moon can be seen glowing a dull reddish colour because of the refracted sunlight, it receives through the earth's atmosphere.

Sometimes the moon passes between the sun and the earth, thus blotting out from our sight a part or all of the sun, thus causing a phenomenon known as 'Solar eclipse.' Solar eclipse can be of three kinds (*a*) 'partial' that is when only an edge of the moon comes between us and the sun , (*b*)

'Annular,' that is when the moon passes in front of the sun and covers all but an outer ring of it ; and (*c*) 'total' eclipse which though the most impressive of all, is a very rare phenomenon and is visible only for a few minutes from a very small area on the surface of the earth—usually a band 180 miles wide.

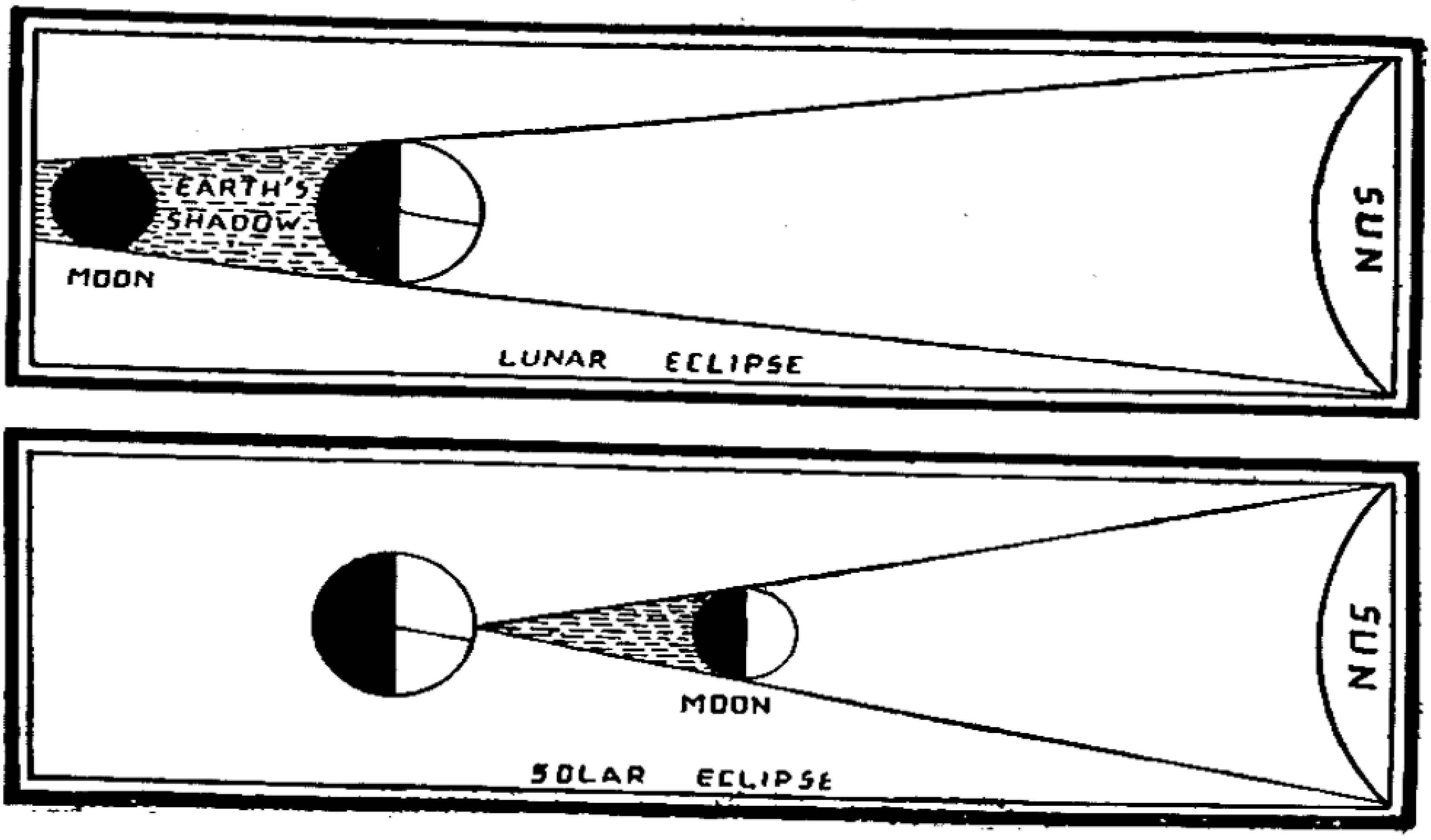


Fig. 34—The Eclipses

The total number of eclipses which may be seen on the earth during a period of 18 years is about 70, twenty-nine being lunar eclipses and about 41, being eclipses of the sun. Eclipses of the sun are seen at different places at different times. It is however, not very true of lunar eclipses which are seen from all parts of the earth where moon is visible at the same time. A total eclipse of the sun usually occurs once after about 18 months at different places of the world.

SECTION E

THE GREAT PARTS OF THE EARTH

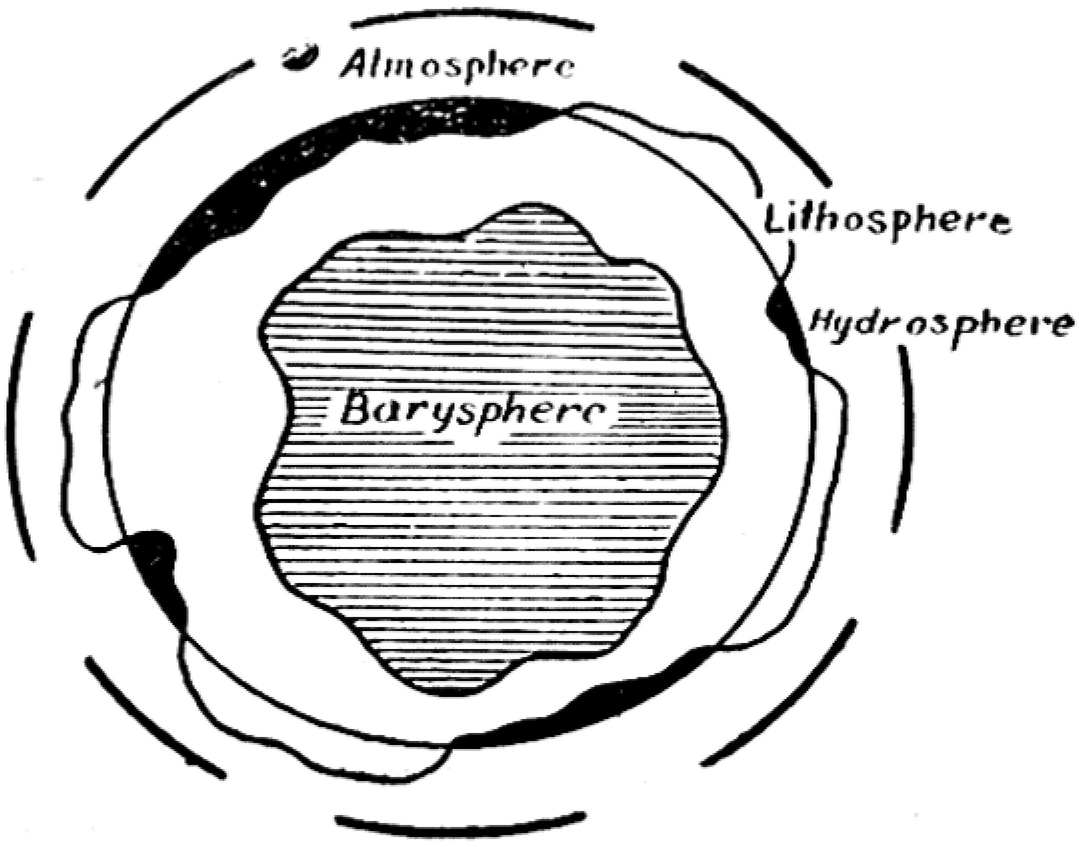
The figure 35 shows the four great parts of the Earth, *i.e.*, (1) the Lithosphere, (2) the Barysphere, (3) the Hydrosphere, and (4) the Atmosphere.

A seperate chapter has been devoted to the study of three of them *i.e.* the Lithosphere, the Hydrosphere and the Atmosphere in the following pages. A brief account of the

Barysphere has been given in the beginning of the chapter on Lithosphere. Here, therefore, it may be sufficient only to mention what they are.

(1) The Lithosphere (or the Rock-sphere) consists of the outer solid covering of the globe and constitutes by far the greater portion of the earth, including not only the lands, but also the rocky materials under the seas.

(2) The Barysphere consists of the interior of the earth beneath the Lithosphere. As such it does not attract much human attention.



CONSTITUTION OF THE EARTH.
Fig. 35

(3) The Hydrosphere consists of the outer covering (only partial) of water. Most of the water is in the oceans, seas, lakes etc.

(4) The Atmosphere means the gaseous covering of the earth. It is also called 'air.'

CHAPTER II

GEOMORPHOLOGY

2

(A Study of the Lithosphere)

1. **Materials of the Earth Crust.**—The solid portion of the earth consists of two distinct parts : (*a*) The 'Lithosphere' or the 'Rock Sphere' consisting of the solid outer crust including not only the lands but also the rocky materials under the oceans. And (*b*) the Barysphere consisting of the interior of the earth beneath this outer crust.

Man lives on the 'Lithosphere' and as such geographers study it in greater details. We have no direct relation with the interior of the earth which, it is said, comprises of Basaltic strata extending to about 1000 miles or more below the Lithosphere. In the centre of this sphere is the 'core of the earth' consisting of metals specially iron and nickel and having a density eleven times greater than that of water. Owing to rapidly increasing tempertures the 'Barysphere' is in a molten state except at the core, which owing to very intense pressure, is solid.

The 'lithosphere' or the outer crust is nowhere more than 50 miles thick. At places it may be much less, say about 10 miles. It is made of materials (rocks) whose average density is only about 3 times greater than that of water. These rocks are of great variety and of varying hardness and are of great importance to man as they affect life to a very appreciable degree. As such a study of the rocks (materials of which the earth crust is made) forms an important part of Geography.

(a) **Rocks** comprise of substances called 'Minerals.' A rock may consist of 5 to 10 or more minerals. Rocks are usually formed in three ways, so it is quite convenient to divide them into groups according to their mode of formation and history :

(*a*) **Sedimentary Rocks.**—They consist of all material

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1. **Heat increases at the rate of 1 c. per 32 meters.**

deposited (usually in layers) by water, wind, etc., Limestone may be quoted as an example.

(*b*) Igneous rocks, meaning thereby all earth material that was once (due to high temperatures) in a molten state. Lava is an example.

(*c*) Metamorphic (or changed) rocks, implying thereby all sedimentary and igneous rocks which have been altered or 'metamorphosed' by heat, pressure or any other agency into something quite different. Slate may be cited as an example.

To the above may be added *organic rocks* which have been formed from living organisms *i.e.*, plants or animals. Coral rocks or coal[1] may be taken as good examples.

(1) **Sedimentary rocks.** As their name signifies, they are rocks that have been deposited in the shape of layers of sediment at the bottom of the sea (Marine) or on the surface of a land mass by running water, wind etc. (continental rocks).

Continental rocks.—Continental (sedimentary) rocks may further be classified thus :

(*a*) ***Lacustrine,*** when deposited in a lake.
(*b*) ***Fluvial,*** when deposited by a river.
(*c*) ***Glacial,*** when deposited by a glacier.
(*d*) ***Aeolin,*** when deposited by wind.
or (*e*) ***Organic,*** when made of the remains of plants, animals, etc.

According to the size of the particles that compose them, rocks may be classed as (1) *conglomerates*[2] (2) *gravels,* (3) ***sands*** and (4) *muds.*

Marine (sedimentary) deposits may be either deep-water limestones or shallow-water gravels, sands or conglomerates.

Sedimentary rocks are usually laid down in horizontal layers. Earth movements often tilt the originally horizontal beds.

(2) **Igneous Rocks**.—These rocks are formed through the solidification of molten materials. Molten rock is composed of a mixture of different minerals, called *Magma.* They are sometimes called '*Primary*' *rocks* because they represent the rocks from which all others[3] have been derived.

The types of igneous rocks are many. They differ in their mineral composition and also in their texture, colour and mode of occurrence. But for our purpose at the present stage, the following may suffice :

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[1] Which has been formed from the remains of plant life.
[2] They are masses of gravel cemented together.
[3] Except certain originally formed sedimentary rocks.

(*a*) **Lava.**—When molten rock material is poured out on the surface through volcanoes or big fissures in the crust, it cools quickly. Such is called *lava* or Volcanic rock. This is usually fine-grained and is also known as non-crystalline rock.

A ' *dyke* ' is a wall-like mass of solidified lava, thrust, when in a molton state into a fissure cutting across the rocks in a position highly inclined to a horizontal plane. They vary in thickness from a few inches to hundreds of feet and in length from a few feet to many miles.

Sills or sheets are somewhat like dykes but their lava lies in horizontal beds between beds of sedimentary or metamorphic rocks.[1] Thick ones are called ' sills ' while thin ones are called ' sheets.'

Necks.—In an active volcano there is a vent or opening which connects the heated, deep-seated material within the earth with the upper surface. In the last[2] stage of a volcano, lava may solidify in this well below the surface of the earth. This intrusion is called a volcanic ' neck' or ' plug.' Extensive erosion may disclose the ' necks.'

(*b*) **Plutonic rocks.**—They are formed when the molten material solidifies at great depths from the surface of the earth. It cools and solidifies very gradually as compared to volcanic rocks and is, therefore, very crystallised. Granite is a good example of this type of rock formation. Earth movements or denudation may expose Plutonic rocks. They are also called 'Crystalline Rocks.'

Igneous rocks are, commonly speaking, not rich in minerals. It is probable, however, that some minerals may be found in the adjacent areas. Igneous rocks have no fossils. Petroleum and coal are also absent them.

(3) **Metamorphic rocks.**—These signify rocks that have been transformed due to pressure, heat or any other action. Very often the change is so thorough that the original characters are no longer present and the new product is totally ' new.' Slate is a rock that has been only slightly metamorphosed. Gneiss (pronounced nice), schist, marble and quartzite are some of the common metamorphic rocks. They are low and hard and not easily weathered.

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[1] The Deccan Tableland is at many places covered by Lava.

[2] or better ' dying'.

Metamorphic rocks are usually very rich in minerals and attract huge mining population.

Age of Rocks.—Rocks differ in age. For instance alluvium is a mere ' baby ' when compared to slates or sandstones. The length of known human history is very short as compared to the history of rocks (Geological time). The following table[1] has been prepared to give a summary of the relative ages of rocks.

Age of Rocks

Era	Rock Groups	Chief Rocks	Minimum Duration
Quaternary	Recent	Alluvium gravels, and sands.	
	Pleistocene.		
Tertiary or Cainozoic.	Pliocene.	Sands and gravels	50 Million years.
	Miocene.		
	Oligocene.	Chiefly clays and sands	
	Eocene.	Sands, gravels, and clays.	
Secondary or Mesozoic.	Cretaceous.	Chalk, Sandstones, and clays.	150 Million years.
	Jurassic.	Limestones sandstones, and slates.	
	Triassic.	New Red Sandstones and marls.	
Primary or Palaeozoic.	Permian.	Red Sandstones, Magnesian Limestone.	800 Million years.
	Carboniferous.	Coal Measures, Carboniferous Limestone, Millstone, grit limestones.	
	Devonian.	Devonian and Old Red Sandstone, shales, slates, and limestones.	
	Silurian.	Sandstones, shales and limestones	
	Ordovician.	Sandstones and slates.	
	Cambrian.	Slates and sandstones.	
Pre-Cambrian (no definite classification.) 1. Protesozoic. 2. Archeozoic.		Sandstone, slates, volcanic rocks, granites, schists, and gneisses,	1000 Million years.

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[1] Prepared from the tables given by Stembridge and W. J. Miller.

(*b*) **Soils.**—Soil is the upper portion of the earth's surface in and from which plants are able to grow. Besides being a mixture of broken and decomposed pieces of rock, it also contains organic matter and varying quantities of moisture. The quality of the soil is an important factor in agriculture as plants derive a good amount of their food from it. The depth of the soil and the fact whether it can be easily broken to allow plant germination are of equal importance.

Some soils are formed in place (locally) from the underlying rocks—***Residual** soil;* others are derived from materials brought by water, glaciers or winds, etc.—*Transported soils.* Transported soils are as a rule more fertile than residual soils. A large portion of the earth's soils, is transported. Residual soils predominate in highlands while the transported ones are found mostly in plains, valleys and lowlands.

It may be useful to sub-divide this type into :—

(*a*) ***Colluvial, i.e.,*** all soils that have been removed only to short distances by agents such as avalanches, landslides etc. They are usually found on or near the feet of steep slopes.

(*b*) ***Alluvial, i.e.,*** soils which have been carried by streams and deposited by them on distant lands. These are well-grained and stratified and are naturally fertile.

(*c*) *Glacial, i.e.,* soils that were originally carrierd by glaciers and formed moraines when the glaciers melted.

(*d*) ***Eolian, i.e.,*** soils carried and deposited by winds ; Heavier matter like sand grains are carried only to shorter distances while fine dust particles may be carried to hundreds of miles in some cases. ***Loess*** is the term given to a deposit of wind-blown dust. Wind-blown sand when mixed with heavy alluvial clay lightens the soil and makes it more useful for cultivation.

Types of Soils.—The following types of soils are generally recognized (1) Gravelley soils, (2) Sandy soils, (3) Clayey soils and (4) Loamy soils.

(1) **Gravelley Soils** :—They are formed by swiftly running water and as such are rather coarse. They do not retain water and there is a danger of crops drying up. Because of the presence of stones, such soils are hard to plough.

(2) **Sandy soils.**—Sand usually contains quartz of grains and has the same disadvantages as gravel. It is porous and as such it can retain no moisture and only very hardy types of trees and plants can grow in soils that predominate in sand.

(3) **Clayey soils** :—Clay contains a fair supply of useful chemicals but it is very sticky and compact and as such presents difficulties in ploughing and does not allow plant-roots to break through easily. When dried it becomes so hard that it has to be left alone for about a couple of years before it can be used for cultivation.

(4) **Loamy soils.**—Loam is a mixture of sand and clay. Humus or decayed vegatable matter also forms a part of loams in varying quantities.[1] When the amount of Humus is great, the colour of the soil gets black as is the case in the Black-earth or Steppe region of European Russia.

Manures and Fertilizers.—Soils are of vital importance in agriculture. After every crop, the soil is poorer in plant food and if no attention is paid towards preserving this 'wealth,' the land may rapidly diminish in fertility. Sometimes the soil of a particular place lacks in certain chemicals that are needed for the cultivation of some crops. In such cases, it becomes absolutely necessary to add these salts by means of artificial fertilizers.

A wise farmer, therefore, is one who knows both these things so as to preserve or renew the fertility of his fields. The Indian farmer has been partly ignoring this fact and little has been done to lessen the strain on the soil. It has therefore, been predicated that if a sane and universal use of manures and fertilizers is not made, the yields shall go on fast decreasing and the fertility of our soils, of which we are so proud, shall be no more ours.

When a total or partial soil exhaustion occurs, the simplest way to recover it, is to let it remain fallow for some time. But this is only feasible in regions where sufficient ground is available. The Indian farmer has been putting it into practice since long.

A quicker method is to add fertilizers. This addition may be in the form of chemicals, farm manure or just mud. Manures like cattle-dung and human excreta are better things, being cheaper and more comprehensive in use. A modern method is called Green-manuring. In between main crops some leguminous crop like 'Sanai' is grown and then ploughed down as a praporation for the next crop.

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[1] The best type of soil for agricultural purposes is the one that contains all the three *i.e.*, sand, clay and Humus in good quantities. Humus is a good fertilizer but left alone, it is not so useful.

Crop rotation is also resorted to in some cases as a useful means of regaining soil exhaustion. Rotation of crops means that different crops are grown from season to season and from year to year. It is also usually practised by the Indian farmer. The idea is to grow crops that require different 'food.' It is called *rotation* because after some time the same series of crops are planted over again.

Soil Erosion :—Soil erosion is a matter of great concern specially in places where agriculture is the main industry. The term simply means the loss of surface soil by the action of wind, running water etc. Vegetation protects the soil from such destructive forces. I Stripped of the vegetation, soil losses are dangerously huge in some places. Cultivation further exposes the soil to the destructive forces of wind, flowing water, etc. Soil erosion is, therefore, a world problem.

Three main kinds of erosion are usually recognised: (1) Sheet erosion, (2) Gully erosion and, (3) Wind erosion.

(1) *Sheet erosion* involves a removal of thin sheets of soil from over the entire extent of the affected area. It proceeds slowly and becomes apparent only when it has already done great damage. It is more prominent in sloping lands.

(2) *Gully erosion* occurs usually after sheet erosion. On account of torrents of rain water, channels or gullies are formed and they get deeper and wider with every succeeding downpour. The ravines of the Jamna Basin provide some of the finest examples of such erosion.

(3) *Wind erosion* is more prominent in places where strong wind is a general feature and loose soil is abundant.[1] In India it is comparatively less important and is noticed in some portions of the North Western regions.

The effects of erosion are many. The first and the most important is the decline of crop yields. The underground watertable is liable to shrink. Large quantities of sand are dumped into river beds and thus dangers of floods are increased.

Soil erosion is a direct result of deforestation and this policy was largely followed in India not so long ago.

Many researches towards a control of soil erosion are being carried out in U.S.A. and other countries and healthy beginnings have been made in certain parts of India as well.

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[1] As in Sahara and Australia.

SECTION II

2 (EARTH MOVEMENTS)

There is enough geological evidence to believe that *earth movements* have always been a permanent feature. These movements are both horizontal and vertical. The forces in action are both 'internal' and 'external.' Internal forces act from within the lithosphere and down below as a result of which phenomena like *folding* and *faulting* occur. External forces act from outside and modify the surface features. They may be called external 'weathering agents' like running water, wind, etc. The major land forms like the mountains, valleys, etc., are the result of the internal movements, while the agents of weathering and denudation try to modify the shapes of these landforms.[1]

The internal earth movements may be classed as (*a*) *Rapid* earth movements and (*b*) *Slow* movements resulting in gradual changes.

(A) **Rapid earth movements :**—Under this category we shall discuss 'earthquakes' that bring about a sudden trembling of the crust. Seismograph recordings (Seismograph is an instrument) indicate that such phenomena are quite frequent.[2] The average vertical and horizontal movements at the surface are even less than one-inch but at times they are even as high as three inches.

Earthquakes are, when of considerable intensity, very harmful to high buildings on the earth surface. The physical changes that earthquakes bring about are at times of considerable magnitude. Many examples could be cited to illustrate this effect of earthquakes.[3] A severe earthquake in 1923 caused remarkable changes in the floor of Sagami Bay in Japan. Some parts of the floor were depressed by more than 1,000 feet while others went up by more than 600 feet. The coasts of Sicily sank by about 2 feet after a severe shock in 1908. It must however, be remembered that such remarkable surface alterations come into evidence only after earthquakes of very severe intensity.

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[1] The surface of the earth is not very irregular, the highest and the lowest points being only about 10 miles from each other. If only one of these agents were allowed to work, the earth would be quite a different affair—being irregular in case of internal forces, while being regular in the case of the external ones.

[2] At an average 4 simple shocks every 24 hours while one of considerable dimensions occurs every three months. Japan has many simple shocks in a day while Italy is reported to experience more than 400 per year.

[3] It is reported that during an earthquake in Nothern India a large part of the country was raised by about 5 inches.

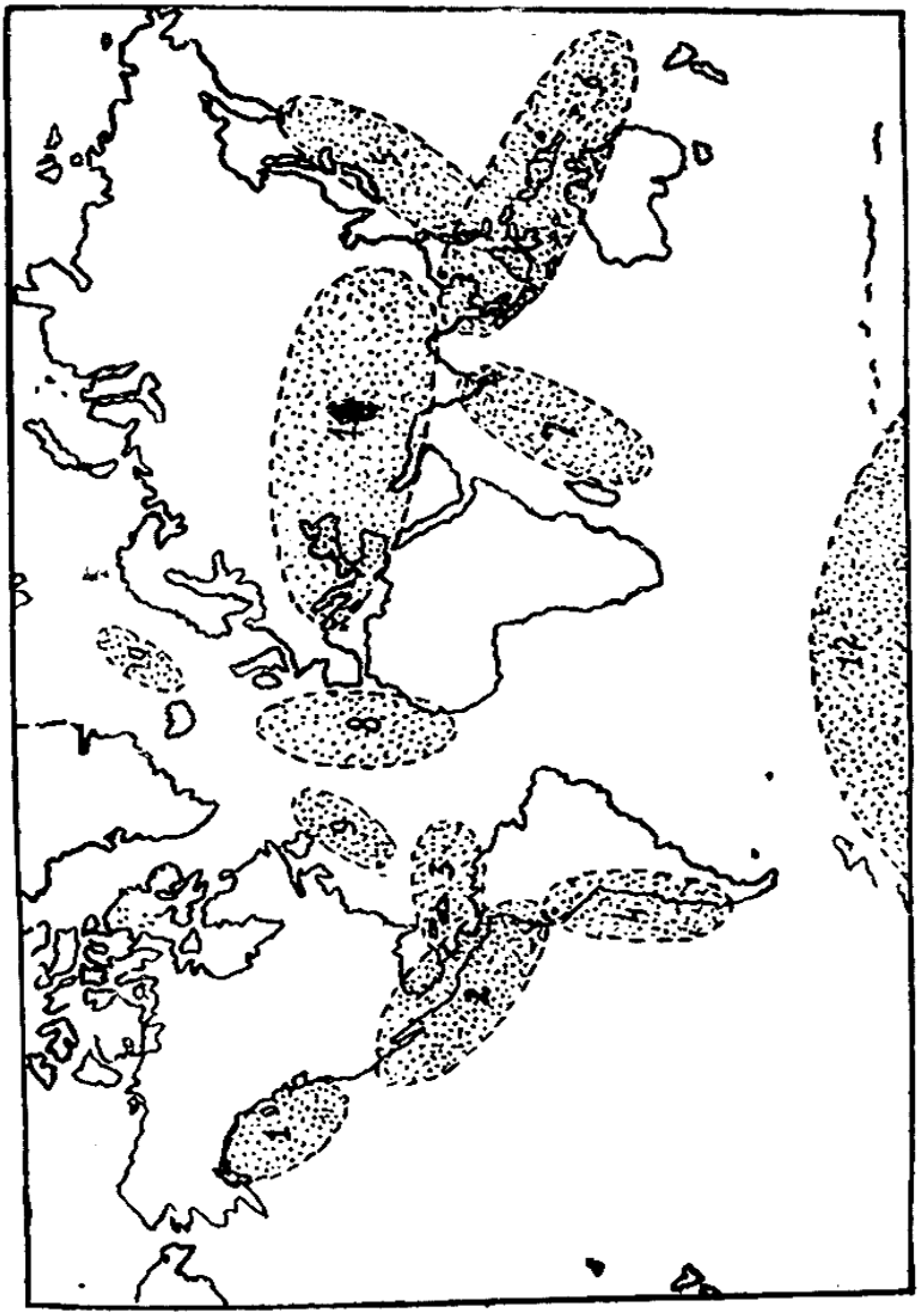
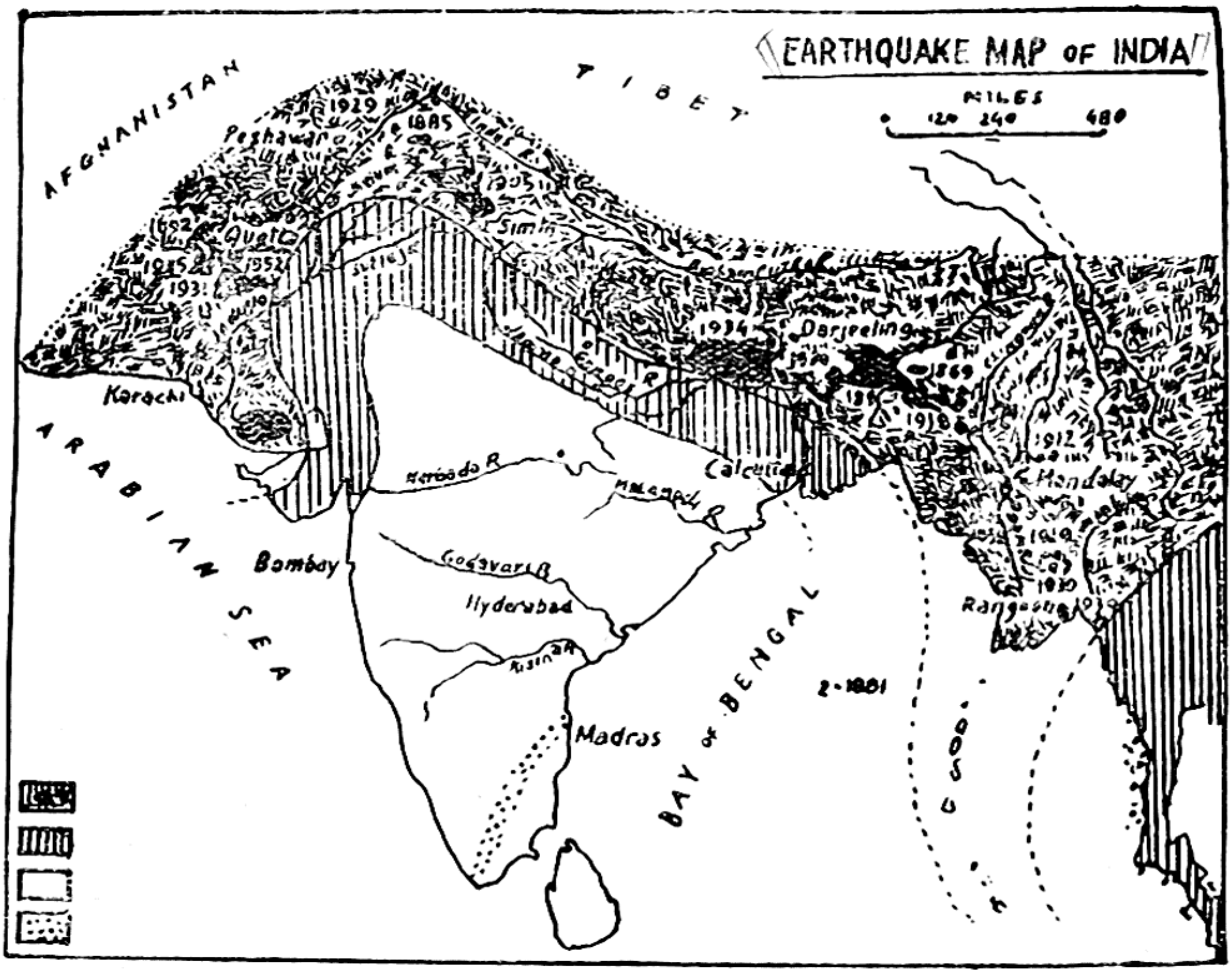


Fig. 36—Earthquake Regions of the World.

Earthquakes are caused by forces beneath the earth's surface. Earthquakes are, however, more closely associated with (*a*) Vulcanism. (*b*) intense folding. (*c*) fracturing and (*d*) intense surface loading. Most of these factors are, however, inter-related. Fracturing, for instance, commonly follows folding as was the case in the Quetta earthquake of 1935.

Intense surface loading[1] and volcanic erruptions are also commonly associated with earthquakes. But it is very wrong to think that earthquakes occur only in volcanic regions.

The map (Fig. 36) shows the world dlstribution of earthquake rigons (or Seismic Zones). The first zone surrounds the Pacific, while the second important zone is associated with the chain of young fold mountains, stretching right from the East to the West Indies. Both the earthquakes and volcanic erruptions are closely associated with lines of weakness. But the earthquakes originate deeper beneath the earth crust.[2]



(Fig. 37—After W. D. West as given by Stamp.)

Before closing this section, it may be useful to learn some other details about earthquakes. An earthquake shock gives rise to 'waves' which radiate from the centre or 'Focus' in all directions as concentric spheres. On reaching the surface,[1] they spread out in ever-widening concentric circles—a phenomenon similar to the one that comes into evidence when a stone is dropped into water.

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[1] The lowest region of North China has experienced several earthquakes due to excessive loading that is caused by wind transport.

[2] About 5 to 20 miles under the earth crust.

'Isoseismic' lines join places of equal severity of the shock. They should, as a rule, form concentric circles; but actually they are distorted as seismic waves travel at different speed in different rock matter.[2]

Volcanoes:—"Volcanic action consists essentially of the escape from the earth of susperheated and compressed gases which may carry rock-matter in various states." The 'cone' or the mountain develops as a secondary feature. A volcano looks like a conical hill surmounted by a small opening (crater) which has a pipe-shaped connection with the interior of the earth, through which lava (*i.e.*, molten rock material), gases and vapour, etc., find their way out. This lava spreads in all directions of the crater and gradually cools and solidifies. Volcanoes are only 'skin-deep' and they have actually no connection with the core of the earth.

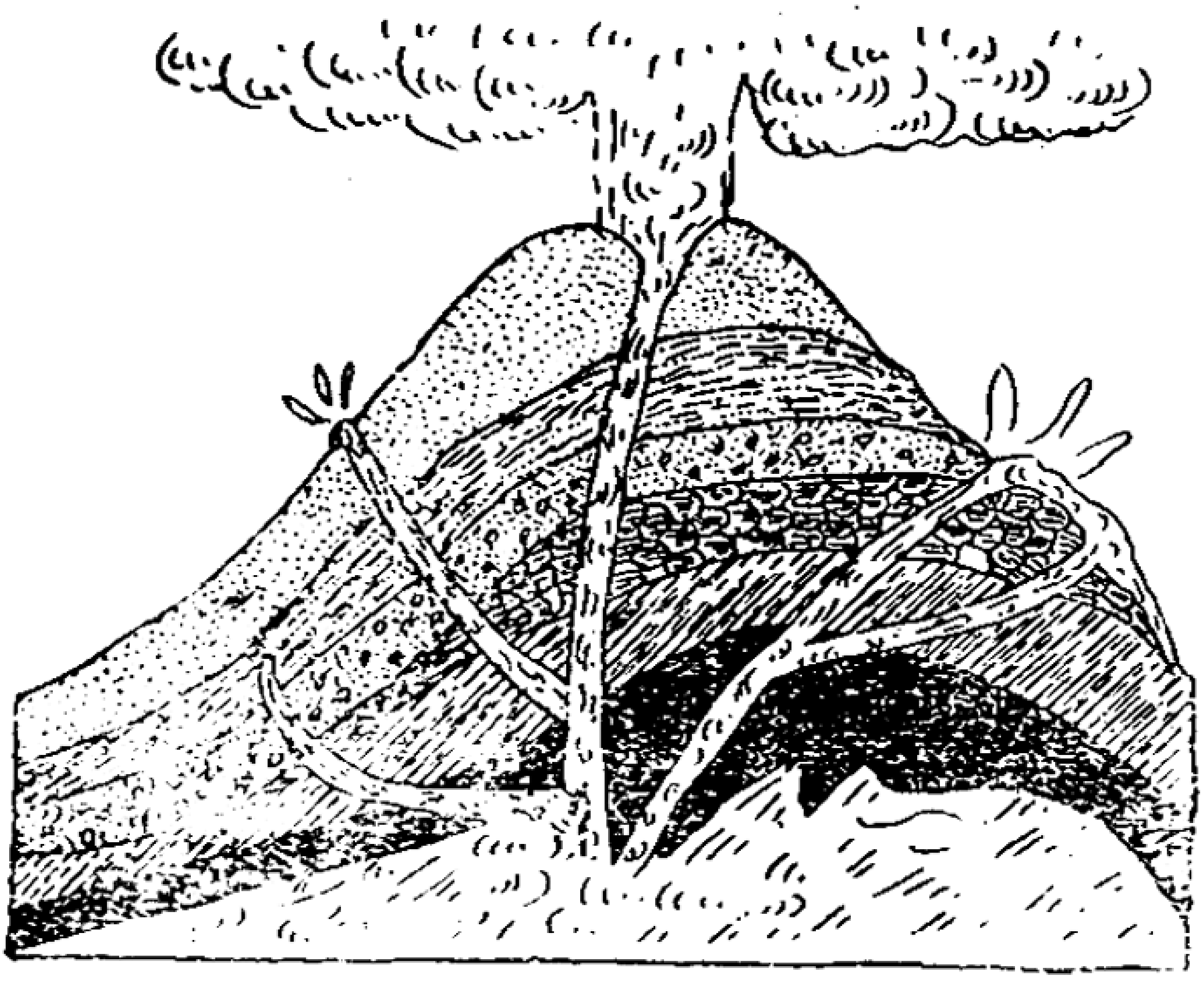

Fig. 88.—Diagram of an active volcano.

It is difficult to find out actual causes of volcanic phenomenon, but the general opinion is that they are due to the 'expansive force' of steam.[3] The presence of steam-down below is due to the access of water (by percolation) to the heated regions below the surface. The steam thus produced forces its way through the weakest points of the crust of the earth.

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[1] The point where the waves first reach the surface is called the 'Epicentrum.'

[2] Waves travel twice as fast in granite as in sand.

[3] Steam explosions are an essential part of almost all volcanic eruptions.

There are about 430 active volcanoes on the earth. Most of the volcanic regions are associated with the earthquake regions because both are connected with the weaker spots. Volcanoes occur along coastal belts of land masses where the land has been subjected to distortion and upheavel and also on the floors of oceans.

The solid matter thrown out by a volcano, is pilled up into conical hills round the 'vent.' These hills usually assume considerable heights[1] after subsequent erruptions. Active volcanoes may be classed as :—

(1) **Central volcanoes** :—These are cones made of lava about a central orific. Steam is poured out in huge quantities and causes heavy clouds and rain. Vesuvius is an imposing example.

(2) **Mud volcanoes** :—In such volcanoes, as the name signifies, 'mud' is emitted out of the crater. This is not very infrequently a sign of subsiding volcanic activity. Mud volcanoes are also known as *Salses*. In India such volcanoes occur in the Mekran coast of Baluchistan and in Burma they exsist along the Irrawaddy and on the Arakan coast.

(3) **Puys** :—There are clusters of cinder-cones and lava-domes.

(4) **Fissure-erruptions** :—Here volcanic eruption takes place through a fissure or a big fracture in the earth crust. Lava wells up through fissures which are finally covered by it. Lava slowly spreads, over vast areas and its thickness increases with every subsequent erruption. North-West Deccan is a good example of such a region.

(5) **Hot springs and Geysers** :—In both the cases hot water flurts out of the volcano. It assumes the form of a fountain of water in the case of the latter and it just flows out in the case of the former. Both of these phenomena usually indicate the last stages of volcanic activity in a region.

(6) **Solfataras** :—They mark the dying out stages of a proper volcano. During this stage steam and acid vapours are emitted out and they cause chemical deposits in the relevant regions. The name has been derived from a dead (or dormant) volcano named Solfatara in Italy.

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[1] Etna.......10,740 feet, Mauna Lena 12,675 feet, Cotopaxi 19,500 feet.

(7) **Marine eruptions** :—Many volcanic eruptions take place beneath the sea. Many islands like the Santorin are 'lava piles projecting out of the sea water.' Such are called 'volcanic islands.' About the shores of these islands marine sediments are inter-stratified with the lava of the volcanoes.

Age of volcanoes :—The age of active volcanoes varies. Etna has been active for about 2,500 years. Geologists, however, believe that the whole imposing construction as it stands to-day ; must have taken much longer (about 300,000 years) to build. Other volcanoes like the Shasta are believed to be nearly one millon years old. We also cannot correctly find out whether a volcano is merely silent or dormant or is extinct. There may be a lapse of many hundreds of years between any two eruptions. The question of the age or life of a volcano is, therefore, a very puzzling one.

Their work :—Volcanoes very often bring about some changes in relief features either by modifying the existing landforms or by making new ones. The regular deposition of lava layers around the cone leads to the formation of volcanic mountains which are an important type of landform. Lakes are formed in the crater of extinct volcanoes. Lava outflows often dam the valleys and thus form lakes. Volcanic earthquakes are an imoportant type of earth movement.

The topography of volcanoes changes with each eruption. Rapid erosion sets in after every eruption and glaciers, streams and wind change the whole shape of the volcanoes.

Their uses :—Volcanic activity causes a concentration of metals and precious stones. Copper deposits of Butte and Montana, the nickel deposits of Ontario and Sadbury, the diamond mines of Kimberley and the iron of Sweden are some of the examples.

Lava is beneficial to farming after it has been weathered because of its many useful salts. The volcanic soils of Java, the lava regions of the Deccan (India), the slopes of Vesuvius and Etna (Italy) are all well-known for their crop producing qualities. Streams originating in volcanic regions bring useful rock material and spread them on the plains and this adds to the fertility of the plains concerned.

The hot water of Hot Springs is often used for domestic purposes. Steam from such springs can be used as power as is done in Tuscany.

(B) **Slow movements.**—These may be further divided into (1) *Epeirogenic* (*Continental*) and (2) *Orogenic (Mountain-Forming)*.

(1) **Continental.**—All the continents show evidence of both downward and upward movements. The proof is found in the presence of marine sedimentary rocks lying on older rock within the continents. This definitely shows that both the land and the sea have been changing levels. It may, however, be remembered that every single continent has its own movements.

Seashores and lake shorelines supply ample evidence of recent earth movements. The most imposing example of downward movement is found in Southern Alaska and the island of Crete. Near the coast of Southern Alaska there are many small islands which are definitely reported to have been parts of the mainland. To the east of Crete, many buildings and lowlands now lie under water. A good number of examples of upward movement could also be quoted. The Atlantic coastal plain of Southern U.S.A. is underlain by marine sedimentary rocks and is reported to have been beneath the sea. Such soils have fossils of oceanic animals.

Such movements may still be going on and it may be said with confidence that similar movements will continue during the coming ages.

(2) **Mountain-Forming.**—These are due to the concentration of great forces within the earth and by means of folding and faulting, raise some areas often to great heights.[1] The rate of movement is slow. A mountain may take a long time to assume its final shape and height. The Himalayas and the Andes are a comparatively recent phenomena (geologically speaking).

It may be added here that earthquakes are also associated with the above-mentioned continental and mountain-making movements.

(*c*) **External Agents of Change** may be classified as under :—

(*a*) Denudation or wearing away of land.

(*b*) Deposition of the rock-material derived from (a) in some other places.

(*c*) Transportation[2] or carrying of material from regions under (*a*) to regions under (*b*).

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[1] Their effect is also downwards.

[2] The process of 'Corrasion' *i e.*, the filing away of rocks during transportation is also related to this.

Destruction is more marked in relatively more exposed places and in regions like mountain slopes where transportation is easier. Softer rocks are more easily eroded. Climate also plays an important role in this process. Erosion is greater in regions of heavy rainfall and lower ranges of temperature.

The agents of change are either of an 'organic' or of an 'atmospheric' origin. Their effects on rock-surfaces are either 'physical' or 'chemical.' Physical changes result from changes of temperature or frost action. In chemical weathering, the acids in rain-water, etc. dissolve the rock minerals. Acids produced by the roots of plants and other decaying vegetable-matter bring about similar changes.

The chief agents of change are (*a*) water (running) including rivers, (*b*) the work of the sea, (*c*) *variations of temperature*, (*d*) *frost*, (*e*) *Wind*, (*f*) *moving ice Plants, animals and men are minor agents of change.*

(*a*) **Water and the work of rivers.**—Running water plays a prominent part in changing the land in moist climates. It works both above and below the surface.

Of the total rain water, some sinks into the ground, some runs off as streams and the rest is evaporated. Climate and the nature of rocks determine the proportions of each of the above. The water that sinks into the ground helps in chemical weathering and is responsible for ground water in the soil. It goes down through porous beds, sometimes coming out as springs at places where the lower harder parts of the bed crop out on the surface. At times it collects in the hollows of folded rocks to form artesian basins. In such regions artesian wells may be constructed (Fig. 39). The figure shows that two conditions are necessary for the construction of such wells :

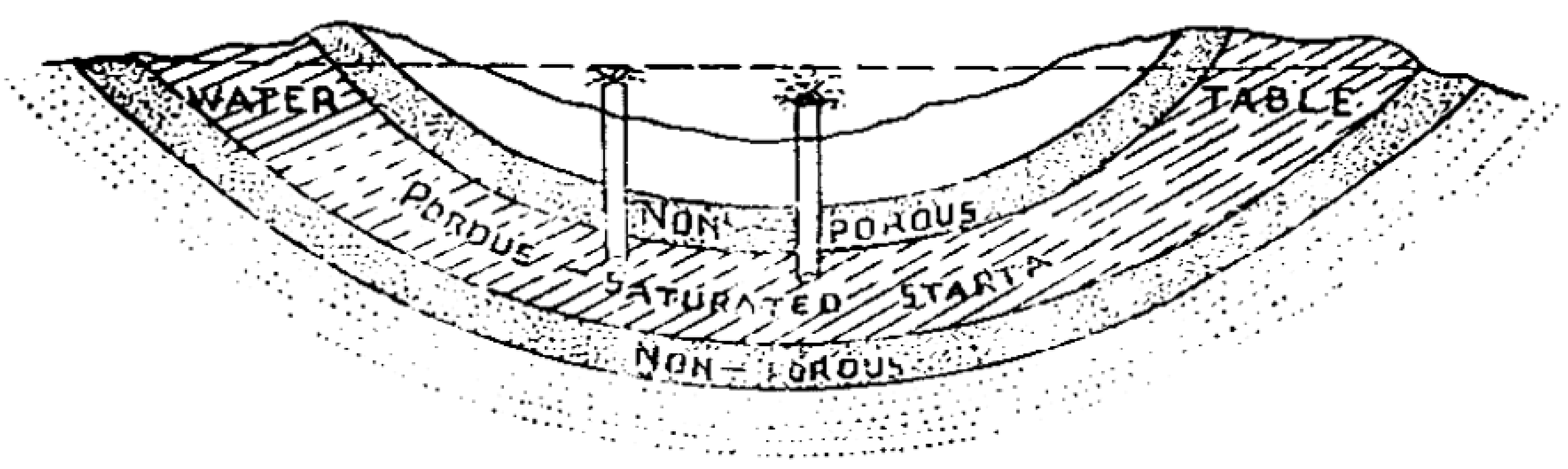

Fig. 39.—Artesian wells. Water enters the ground through the surface-edges of the porous strata and remains there, till it is let out by means of tubes.

(1) The strata must be 'basin-shaped' and (2) that

there should be two non-porous strata sandwiching the porous strata. The rain water collects in porous strata. A long tube is bored through the upper non-porous strata into the saturated porous layers. The water retained there comes up the tube upto the level of the normal water-table. It is only during severe droughts that water may cease to flow.

The run-off water forms streams and rivers. These carry particles of rock and corrade their beds. Their carrying (or transporting) power depends on the amount and velocity of water.

The 'physical action' of rain water may easily be seen after a strong shower. At places where the rainfall is heavy, deep gullies are formed and all the drains are full of muddy water. Its effect, however, is most marked in sloping ground specially in mountainous regions with high rainfalls.

The chemical action of rain-water is due to the presence of carbon dioxide which is a very powerful eroding agent specially in limestone regions. Soluble rock is dissolved by rain-water and juttings like 'peaks and pinnacles' are consequently formed. In highly soluble regions (*e.g.* the limestone districts of South-West France) rivers often make tremendous gorges. Sometimes a stream flows as an under-current for some distance and forms caves[1] that get deeper and deeper with every subsequent cut of the river.

In regions of widespread surface limestones, streams dissolve that limestone and form lakes known as *solution lakes*.

The work of Rivers.—In changing the shape of the earth, surface rivers or streams play a three-fold role, *i.e.* (*a*) Denudation or wearing away of rocks, (*b*) Transport of the denuded material, and (*c*) deposition. The result of this is a general levelling of the surface. When the regions around the source of a river have been eroded to the level of its mouth, the *Base level* is reached, *i.e.* the river can erode no more. The ultimate effect of rivers on a hilly region is to reduce it to a fairly uniform slope with wide valleys of very slight gradients. Such a region becomes 'almost a plain', technically called a *Peneplain.*

The volume and velocity of river-water plays a very important part in determining the extent of the 'work' of a river. A river having a lot of water and flowing at a high speed can carry big pieces of stone.[1]

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[1] 'Stalacites' *i.e.* hanging stones from the roof and 'Stalagmites' *i.e.* 'pillars' rising from the floor, are special features of such caves.

In many rivers where the rainfall is heavy all the year round (*e.g.* in the equatorial region) a uniformly high volume is maintained. In others it varies according to the rainfall variation. As a rule all the rivers shrink during dry and hot weather. Those in the Mediteranean area are full only in winters because of the winter rainfall. Rivers that depend only on mountain snows and ice, and the rivers in the northern regions flood in spring when the snow and ice melt.

A '*river system*' signifies the whole course of a normal river. It includes all the tributaries that join it during its journey to the sea. In short, it includes all the water[2] coming into it 'singly or as a collective stream.' The area drained by a river system is called its 'Drainage Basin'.

The normal course of a river may be divided into (*a*) Mountain stage, or the upper course, (*b*) The valley course or the middle stage and (*c*) the lower course or the Plain stage including the Delta stage.

(*a*) *The upper or the mountain course.*—This is true of most rivers as they usually originate in mountains where rainfall is generally heavy and snow is a permanent feature. The presence of snow at the origin of a river assures a minimum supply of water although the rivers swell considerably during rainy season as is the case with the rivers of northern India. Unlike these if the highlands concerned are not high enough for snow, the rivers become mere streams during dry season as is true of the South Indian rivers.

In the beginning, a river is a collection of swift mountain streams that erode and carry big loose stones, boulders, pebbles, etc. which, as they advance in their journey, get smaller in size and go on eroding the sides and the beds of the valleys which get deeper and wider. Rivers also tend to cut their valleys backwards so that a *water-divide*[3] assumes a zig-zag form. This cutting back often results in the *capture* of one river by the other.

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[1] The river water carries at the following rate :—(1) at 8 miles an hour, pieces 4 feet across, (2) at two miles an hour, egg-sized pebbles, and (3) at $^1/_4$ mile an hour only finest sand.

[2] It is estimated that a quarter of the rain-water is carried by the surface streams or rivers to the sea.

[3] A ridge between two sets of streams is a Water-Divide.

In dry climates there is little weathering of the rocks on the sides of a river-valley which are steep,[1] while in wetter regions, the rate of weathering is much higher and the valleys are somewhat broader with gentle slopes on the sides (V-shaped valleys).

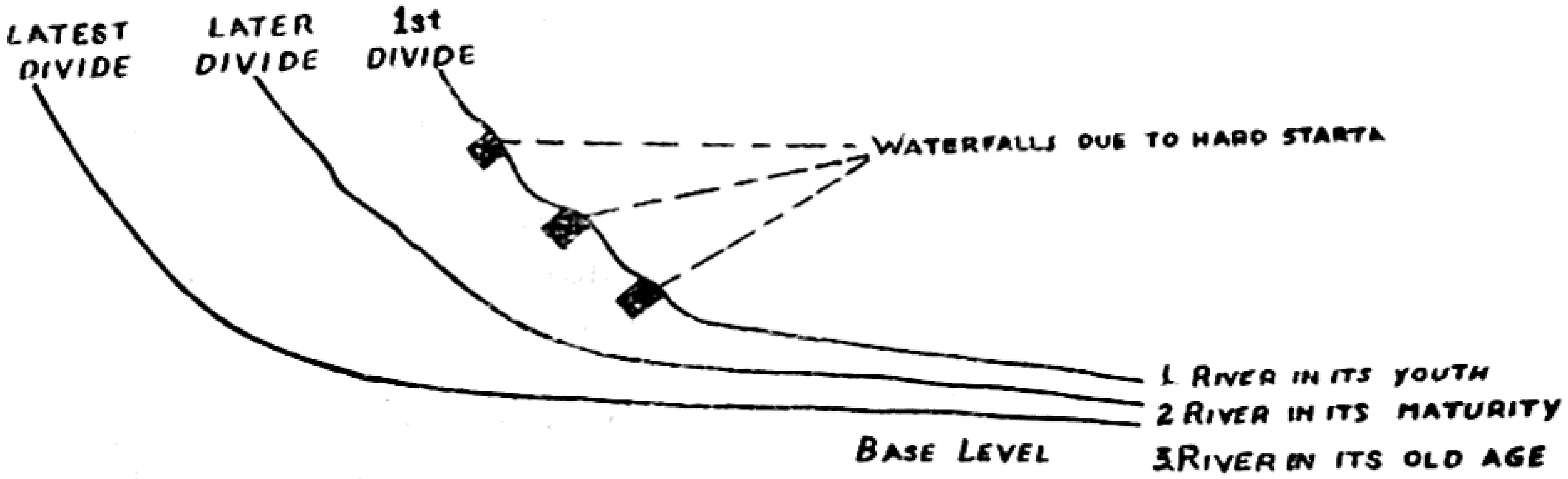

Fig. 40.—Stages in the age of a river (after F.M. Miller).

Water-falls are very characteristic of a river during this stage. Hard rock is denuded slower than soft rock and this brings about many irregularities in the river-bed. These, irregularities, however, get smoothened as time passes (Fig. 40).

(*b*) *The valley or the middle course.*—When the rivers enter their more gently-sloping valley course, they flow more slowly. Consequently their 'carrying power' and the power of eroding of the sides and the bed get weaker. They, therefore, wash away the banks and the bed is considerably widened but not deepened. The shape of the valleys resembles that of a widened 'V'.

Matter which is too heavy to be carried is deposited mostly on the sides. The current being strongest in the middle, it is kept clear of all debris. At this stage the river is said to be 'aggrading' its bed. During floods layers of sediment are deposited all over the 'flood plain'.

(*c*) *The lower or the plain stage.*—As still flatter land is reached, the river loses much sediment or alluvium on its bed which is as a result of this, rising continuously.

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[1] The I-shaped valleys or the canons of the Colorado and the Snake rivers are fine examples of this.

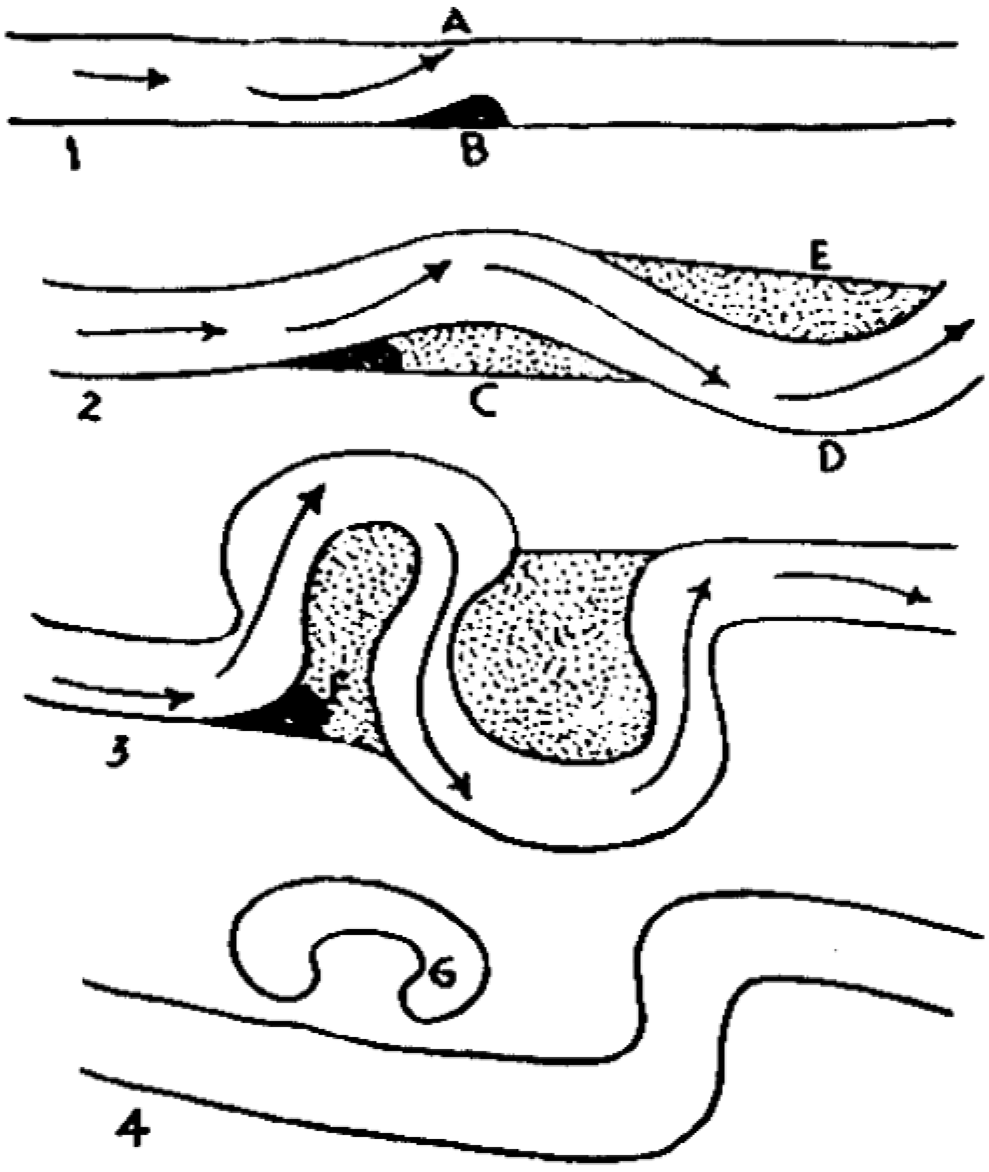

Fig. 41 Stages in the meandering course of a river

The river has also been joined by its various tributaries and other drainage and it flows over a wide bed in a zigzag channel, because owing to its slow speed and consequent low force, it does not cut through obstructions but winds around them. The figure 41 shows this meandering character of an average river very clearly. Many meaders are abandoned because of the change in the erosive activity of the stream and thus are formed *ox-bow lakes or mortlakes* (called ox-bow because of their shape).

Some rivers carry such a big amount of silt that their beds are slightly raised even above the level of the surrounding plain.[1] The banks of such rivers have to be dammed (raised and strengthened) because they are liable to cause disastrous floods.

Sometimes the land over which a river flows, rises .The speed of the river increases and it begins to cut down to a new level. This makes river terraces which are safe from the danger of floods.

Consequent streams are the 'first' streams that start on an uplifting piece of land and flow according to its slope. Gradually the land is worn down and weathering exposes the underlying rocks, and *secondary or subsequent* streams develop along the lines of weakness. They usually occupy bottoms that lie at right angles to the main streams. With the gradual growth and the deepening of the subsequent streams, escarpments of hard rock material come into existence down which flow small streams in an opposite direction to the main drainage. These are known as *obsequent streams.*

When the consequents cut narrower valleys through the escarpments laid bare by the subsequents, these narrower valleys are called *water gaps.* Water gaps are also formed by river capture.

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[1] For example, the Rhine in its lower course is above the level of the Plain of Holland.

If the consequents cut more rapidly than their neighbours, their subsequents are able to erode the heads of their valleys rapidly and perhaps also lower their beds below the level of that part of the neighbouring consequents which are above their *water gaps.* The waters are now diverted into the long subsequents instead of into the consequents. Those water gaps are left empty and are called *wind gaps.*

In folded Regions:—The given figure 42 shows the developement of valleys and rivers in a folded area. The main streams occupy the synclines or the downfolds and the minor tributaries flow down the slopes and enter the main streams at right angles. The tributaries flowing down the slopes cut headward into the adjacent ridges and eventually capture steams flowing down the opposite slopes.

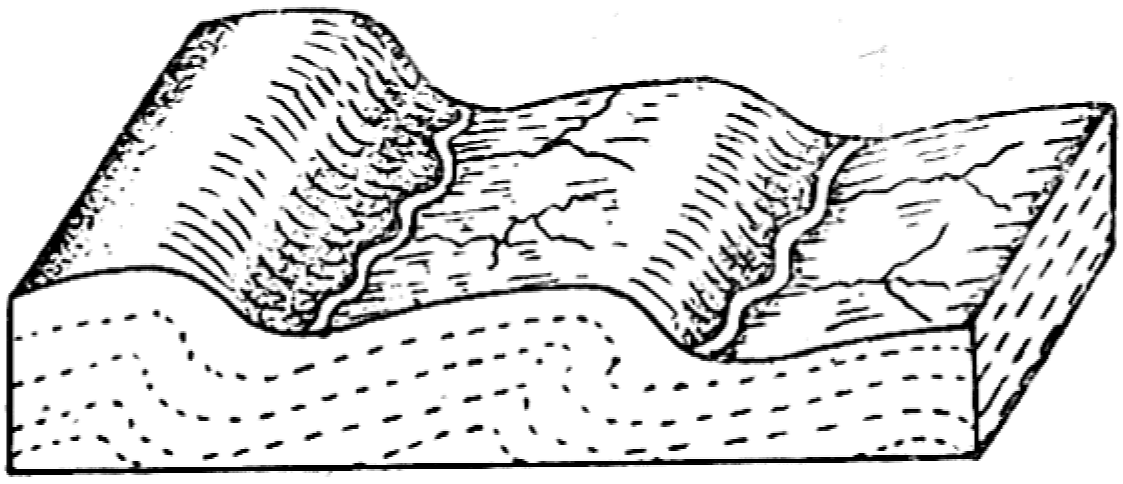

Fig. 42. Rivers and valleys in a folded region.

The anticlines are often so much eroded that they become as low as valleys. Weathering in the valleys being much lower, the original synclines may form higher regions. This is called the *Inversion of Relief.*

The topographical cycle in rivers :—The age of the topography can be best determined by a study of the forces of 'water erosion.' It may therefore be useful at this stage to enquire into the various stages in stream developement.

Stream development or the 'cycle of water erosion' may be divided into 3 stages :—

(*a*) *Youth.*—When the spread of the main river and its tributaries is swift and they rapidly cut sharp V-shaped valleys.

(*b*) *Maturity.*—When the speed of the streams decreases as their beds are now close to the base-level and the gradient is lower. The valley is broadened as the side erosion is greater.

(*c*) *Old age.*—When there is practically no downward cutting and the speed of water is very low. The valleys have become broader still. And the surface is reduced to a *peneplain* (almost a plain).

Rejuvenation is possible at any time during the above stages. Earth movements like folding or tilting or uplifting of an area may increase the gradient and consequently the speed of the streams and thus cause rapid downward cutting.

It may be interesting to learn that every river system is neither wholely young, mature or old. It has all the stages represented within itself. Youth is present usually in the headwaters. The middle courses may be mature. And old age might have dawned in the lower stages. The nature of rocks (hard or soft) and variations in climate also affect the erosion.

(*b*) **Work of the Sea :**—The erosive action of sea waves is very imposing to behold. The crashing of sea against cliffs is a thing of every day experience on sea-shores. The breakers gain greater force during storms.[1] The force of the waves and hence their erosive action is greatest in areas of high tide, during strong winds and where the waves contain shingle and in regions of steep coastal slopes.[2] If left alone, the effect of sea erosion may be to straighten the coastline.

With the dashing of waves (against a cliff or a rocky shore) water enters cracks, etc., and dislodges (or better shatters), rock-material. Many openings are filled with compressed air whose pressure is considerably relieved on the retreat of the waves, thus producing a ' suction ' which often leads to a dislodging of rock masses.[3] Chemical action (like solvent action, of the sea water is also responsible for changing the shape of the coastline. Pebbles and other rock fragments are hurled against the cliffs (specially against their feet) and may lead to their 'crumbling down'. Water specially rain-water, passes down porous rocks (like chalk) to an impermeable bed and spreading on it leads to a phenomenon called ' landslide.'

A sea cliff or a seaward steep front is developed in regions of mountainous shores. With the retreat[4] of the above a wave-cut terrace[5] with a slope towards the sea, is developed. These terraces are usually of moderate width. Towards the sea-ward end of this wave-cut terrace, is

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[1] It is estimated that during storms, the force of breakers may be anything upto 25 tons per square yard or even more.

[2] Shallow coastal shelf breakes the waves and takes away much of their force.

[3] A Hydraulic Pressure is caused which leads to this disruption of rocks.

[4] The rate of this retreat differs from place to place. A cliff of loose rock material is cut back more rapidly.' In south-eastern England the rate is about 7 to 15 feet per year.

[5] A wave-cut-terrace may be uplifted to form a coastal plain of marine erosion.

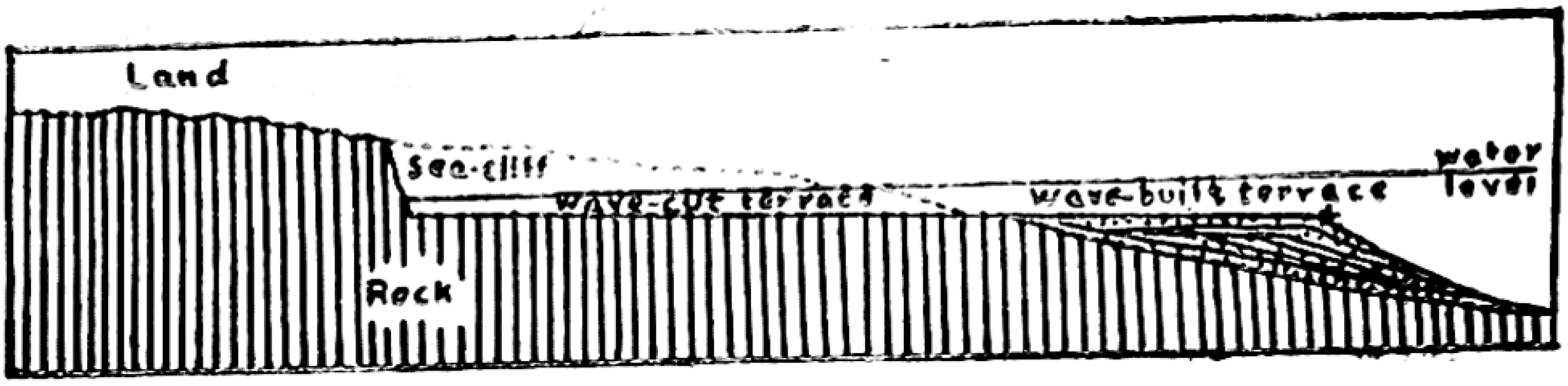

Fig. 48. The work of sea waves (after W. J. Miller)

deposited much rock material and this results in its extension. This newly built portion is called a *wave-built terrace* (see the relevant figure).

Sea caves are often cut along the bases of the cliffs by wave action more commonly where weaker rock-material is situated at the sea-level.

Along coasts where softer and harder rock horizontally alternate each other, the former retreat faster while the latter remain jutting into the sea. These formations are known as *sea coves* and *headlands*, respectively.

Sea Arches or a *sea-bridges* result from the collapse of a part of the roof of a sea cave or by the unision of two caves on the either sides of a headland.

Where wave erosion is unequal, harder portions of cliffs are left standing singly—*stacks*.

The effect of sea or wave erosion, however, is not so widespread and imposing as the work of 'sub-aerial agents' (like rivers, etc.). It has also been noticed that *marine deposition* is much more in evidence along the margins of land masses than marine erosion.

Marine Deposition:—Broadly speaking sea may deposit its 'goods' either in deep sea or in shallow water. With a brief reference to deep-sea deposits, we shall pass along to the shallow-sea deposits because they are more important from the human point of view.

(*a*) *Deep-sea Deposits* consist mostly of shells and other organisms. Deep-sea oozes made up of the 'remains and shells of tiny animals and plants' cover about 60,000,000 sq. miles of the deep-sea bottom. At greater depths a typical variety of 'red clay' is found. In very deep seas remains of plants and animals do not even reach the bottom but are dissolved in the way.

(*b*) *Shallow-sea deposits* are, as is natural, found over the continental borders.[1] As such they comprise mostly of material[1] brought down by rivers and that broken up by waves of the sea.

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[1] To about 100 to 300 miles from the shore.

The building of *deltas* by surface streams is an important item in the list of shallow-sea deposits. They build out into the sea and comprise of 'land-derived materials' carried by rivers. One also comes across the building of deltas in lakes where some rivers fall.

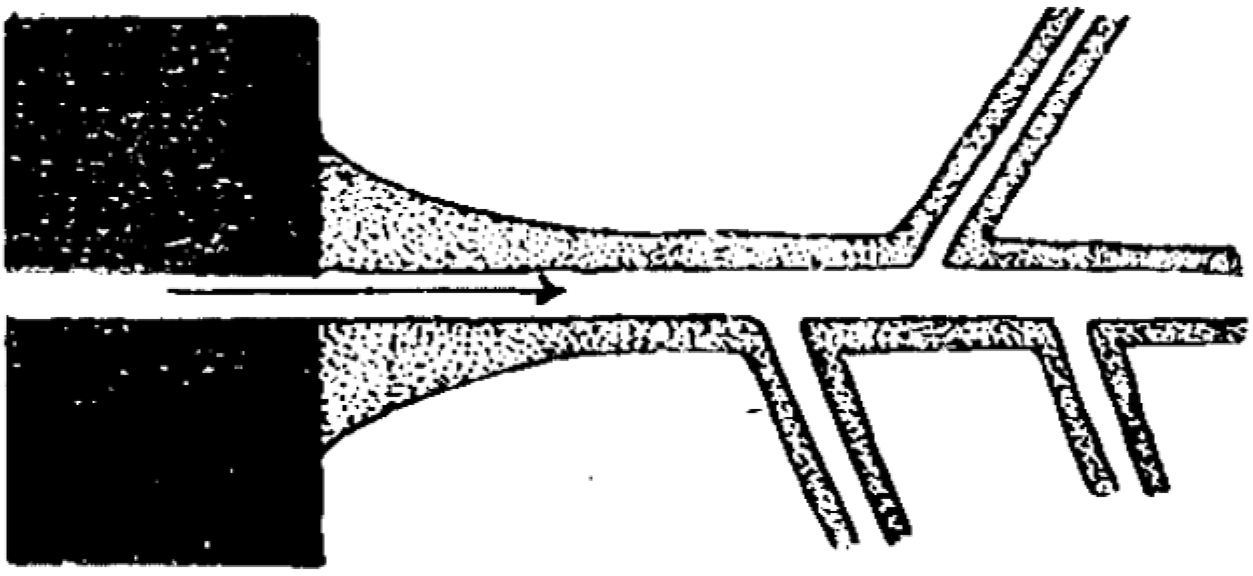

Fig. 44. Section of a Mud Delta (after De Mortonne)

This deposition of sediment at the mouth of rivers is made possible by the very slow speed of the particular rivers. Their building is, however, possible only in regions of weaker shore currents and tides.[2] The new landform is fan-shaped and partly submerged and is called a *delta* because of its triangular shape. Larger and more imposing deltas are usually formed in lakes or partly enclosed seas by big rivers that bring large quantities of sediment. The deltas of the Nile (10,000 sq. miles) and the Mississipsi (12,000 sq. miles) are very good examples of large deltas. In India the Ganges (along with the Brahamputra) has built a magnificent delta (50,000 sq. miles) inspite of the rather forceful tides because the quantity of sediment brought down is extra-ordinarily large.

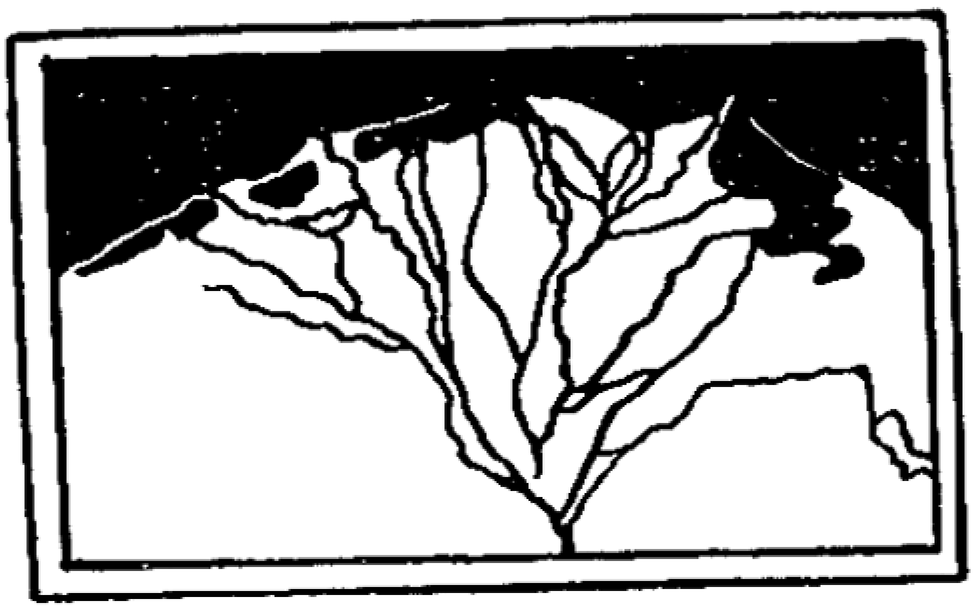

Fig. 45. Delta of the Nile.

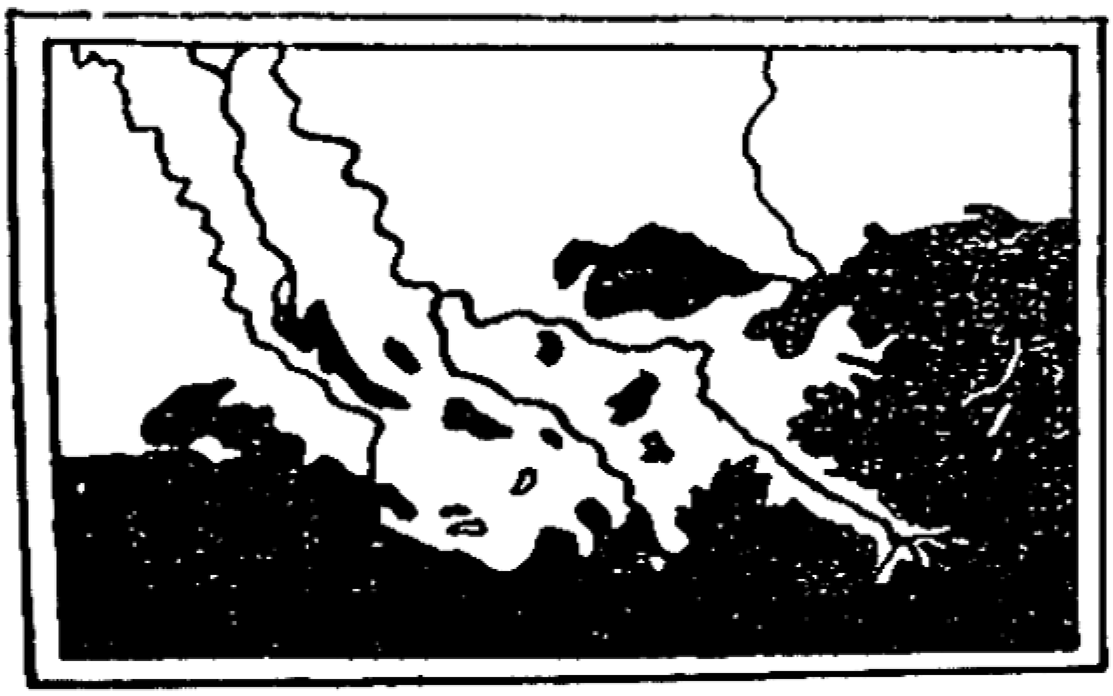

Fig. 46. Delta of the Mississipi.

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[1] Every year a river brings with it several hundred million tons of sediment into the sea.

[2] In some cases as in the instance of the St. Lawrence in Canada, the recent subsidence of the land is equally responsible for the absence of deltas.

The deltas result in the splitting of the main stream into branches.

Fig. 47. Delta of the Rhone in France.

It may be interesting to learn something about the rate of the growth of a delta. The rate of growth differs from river to river. The quickest growth yet recorded is that of the delta of the Mississippi which is reported to be increasing at the rate of 1 mile in 16 years. The Rhone in France is building its delta at the rate of 1 mile in 100 years. The rate of the Ganges delta is also quite interesting.

The delta soil, as a rule, is deep and fertile and usually these areas have a dense agricultural population. The Yangtse delta in China, the Ganges delta in India, the Nile delta in Egypt and the Mississippi delta in U. S. A. are imposing examples of areas having huge agricultural populations. A few typical difficulties are, however, inherent to delta regions. Seeman has summarized them beautifully in his book, 'Physical Geography.' "Inundations may be of almost yearly occurrence or an annual threat. Street improvements are difficult because building stone must be brought from outside regions. The question of domestic water supply is among the first to be faced by the inhabitants and frequently remains serious; the problem is sometimes partially met by catching rain water and storing it in cisterns. Sewage cannot be disposed in the rivers, for the water may flow at a level above the houses. The disposal of heavy rain water is usually a real problem on account of the low elevation and the constantly saturated soil. Communications with the outside world may be confined to river transportation until railroads are constructed along the levels; bringing products from the hinterland to the city may be difficult."

Coast Lines:—The following are the typical varities of coast lines :—

(1) Low shelving beaches.

(2) Sand banks often containing lagoons and marshes.

(3) Lofty cliffs which may be either straight and uniform or irregular and very complex.

(4) Mangrove Swamps common in rainy Tropical coasts.

Coasts may be further classified as 'raised' and 'sunken' (or coasts of emergence and coasts of submergence). The raised coasts are ordinarily very irregular and broken (indented) and usually abound in useful harbours. The much idented coast of Norway (Fjords) has been derived from the sinking of the land.[1]

(*c*) **Variations of Temperature.**—Hot and dry regions specially those lying in the interior are subject to great variations of temperature from season to season and from day to day, *i.e.*, they have marked daily and seasonal ranges of temperature. This is due to the lack of moisture in the soil and also to the absence of vegetation. The rocks expand by day and quickly contract by night and thus the surface layers are broken and subsequently every particle becomes separated from others. Wind carries the particles along with it.

(*d*) **Frost.**—The work of frost is more marked in temperate regions away from the Tropics...beyond about 37 N. and S. Rain and other water penetrates through cracks and other rock openings and frost tends to freeze and expand it, thus splitting the rock into pieces. The subsequent cycle of freezing and melting causes the same results. Water containing carbon dioxide accentuates the effectiveness of this action specially in limestone regions. Hydration (*i.e.*, the disintegration of rock material into insoluble clay minerals, *e.g.*, Kaolin, under the chemical action of ground water) is another kind of chemical weathering.

On mountain slopes such separated pieces of rock may slip down the slopes and consequently combine to form a *Scree* (a pile of loose rock material).

(*e*) **Work of the Wind as an Agent of Change.**—The least spectacular and yet the most widespread and universal of the agents of change is the wind. Its direct effect on land-forms is largely due to its transporting qualities and hence its activities are usually carried out in conjunction with other erosive forces to lower elevated portions. Wind's capacity to transport materials depends greatly on its velocity. Its work is easier and more prominent in regions where there is little or no vegetation to protect the soil and where the large diurnal ranges of temperature have broken the soil particles. This fine-grained rock-material is deposited on the land surfaces elsewhere specially on the margins of moister regions. This fine material is known as *loess* and is noted for its richness and fertility. In central U.S.A. and in Northern China, loess covers large areas.

Along sandy shores and in deserts, wind piles up sand into hills or long ridges called *Sand Dunes*. Dunes are the characteristic landforms caused by wind. *Barchans* are semi-circular sand-dunes with a hollow in between.

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[1] Which has also resulted in flooding the old river valleys —*Drowned valleys or Rias*.

Seif dunes are long, narrow ridges lying parallel with the wind; usually a number of seifs are joined together to form a line of dunes.

Weathering caused by wind may also be chemical. In wetter regions the oxygen of the air may produce oxides and thus disintegrate and decay rock surfaces. This process is called *oxidization.*

✓(*f*) **Work of Moving Ice.**—This particular type of activity is confined at present to the high mountains and valleys and to the Polar regions, where there is sufficient snowfall for glaciers and avalanches to be formed. Glaciers may be called moving rivers of ice and snow. This ice does most of its destructive work with the 'tools' it carries. Where the ice forms, it freezes to the surface particles of rock and as it begins to move it plucks out or breaks off pieces of rock and some quantities of gravel. All these scratch and polish the sides and bottom of the valley with the movement of the glacier and much damage is done. The average rate of movement of valley glaciers is about two feet a day; but it differs from place to place, year to year and from season to season.

The material transported and deposited by a glacier is called *Drift,* and the accumulation of drift is called a *Moraine.* When two glaciers meet, the moraine formed in the middle of the united glacier is technically known as *Medial Moraine.* If it is deposited at a place where the foot of the glacier stands for some time it is called *Terminal Moraine.* Terminal Moraines stretch right across the valleys as a dam. If the moraine is deposited by the main stream of ice as the glacier is rapidly melted back, it is called a *Ground Moraine.* It is usually a scattering of material spread unevenly over the surface just as it was deposited by the main stream of the glacier that melted back more rapidly than it moved.

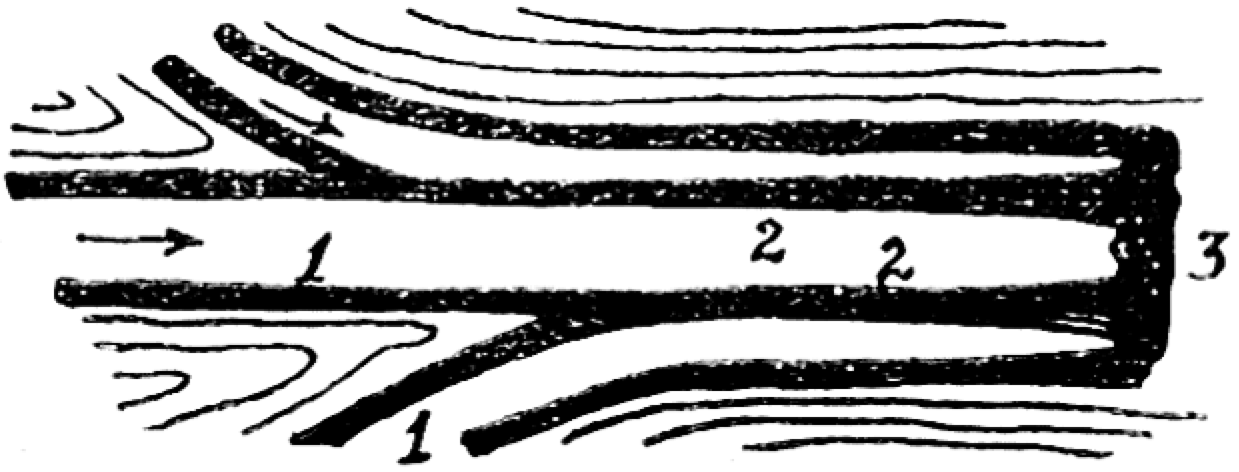

Fig. 48—A glacier and its tributaries. 1 shows *Lateral Moraines*; 2 shows *Medial Moraines* and 3 shows *a Terminal Moraine.*

To-day about 6 million square miles of land are covered by ice. *Continental Glaciers*[1] are found covering Antartica and Greenland and at one time covered North America up to the North of the Missouri and Ohio rivers and also North-Western Europe up to North of the Alps. *Valley Glaciers* are found among the mountains of Western North America, Norway, Switzerland and New Zealand. There are also a few glaciers in the Northern highlands of India.

U-shaped valleys are the chief characteristic features of of valley glaciers. These valleys are steep-sided and relatively broad-bottomed (Fig. 49) Tributaries often join the main valley at or near the top and are therefore called *hanging valleys.* Such valleys exist in the Lake district and the Scottish highlands. Hanging valley are an important feature of formerly glaciated regions. Rising ocean levels bring these U-shaped valleys under water and they are turned into *fiords.*[2]

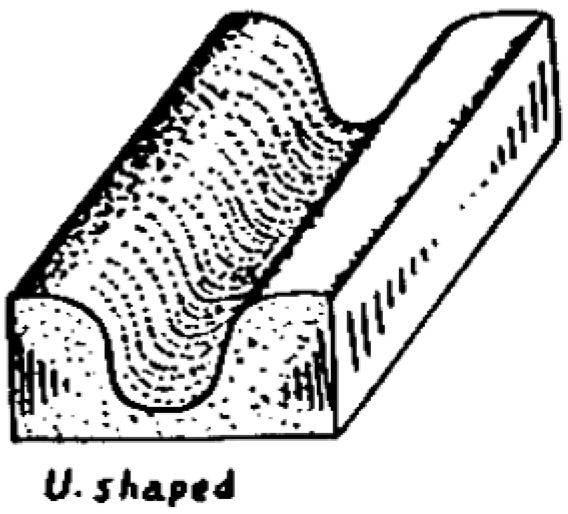

Fig. 49—U-shaped or glacial valley.

Sometimes *Corries* and *Cirques* are cut out of the normal regularly concave stream slopes. These are 'Armchair-shaped hollows, flat-bottomed or containing lakes and tarns, Greatly developed cirques are separated by narrow steep ridges called *Aretes.*

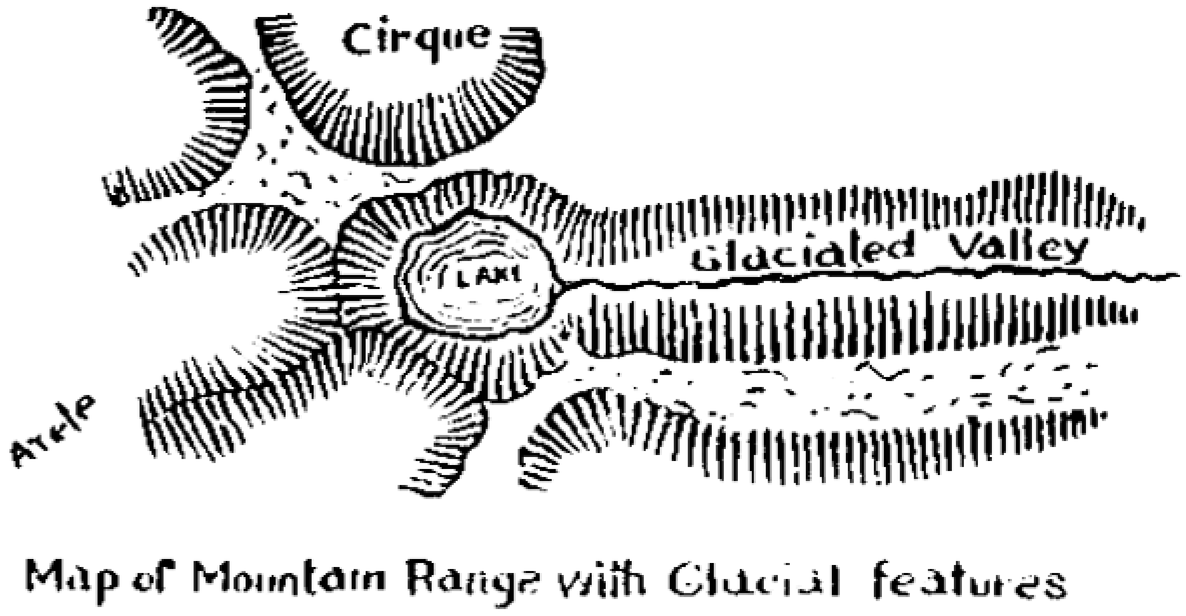

Fig. 50—Features in a glaciated region (after Stamp).

In lowlands ice has removed the soil and a *glacial pavement* (polished and smoothened rock) has been made. Sometimes one comes across 'scratches' that tell the direction of the movement of the ice-sheet or the glacier. The ice sometimes wears hollows in the rock of its channel or bed and when the glaciers disappear, they become small lakes, thus producing in that region a very irregular and complicated network of waterways.

Areas of deposition usually surround such heavily eroded regions. A good example may be found in the heavily glaciated area of central Sweden which is surrounded by the drift-despositions of Finland. Such eroded areas are ordinarily characterised by thin soil and rock-basin lakes.

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[1] Or ice sheets.

[2] The fiords of the coast of Norway, Southern Chile and Alaska are good examples.

The morainic material is carried by a glacier with it and when it melts, that matter is deposited as boulder-clay (clay containing boulders) or glacial sand. *Drumlins* (low, extended hills of glacial sand and gravel) and *Eskers* (gravel ridges) are often formed at this stage.

Sometimes (though it is rather a rare phenomena) old morainic deposits turn a river or stream from its original course. The Derment in East Yorkshire (England) has been deflected into the North Sea by such a deposit.

The Ice Age.—In the end of this section, it may be useful to say a few things about the *ice age* during which about 12 million square miles were covered by ice and snow. The ice age lasted roughly between 800,000 to 20,000 B.C. and its topographical effects are still visible because geologically speaking it was not so very long ago (Quaternary Period). During this space of time the ice-sheets grew and shrank many times perhaps owing to variations in climatic conditions. It is also said that glaciers often meandered for beyond 45°N in the Northern hemisphere. The Northern half of North America and about $\frac{1}{3}$ of Europe were affected at one time or the other. In England the Southern limit extended upto London and Bristol.

Section III

LAND FORMS

The upper surface of the earth crust on which we live is very irregular. The deepest point is about 35,400 feet deep and the highest (Mount Everest) is about 29,000 feet high. That is to say that the extreme inequalities have a range of about 12 miles.[1] The sea-level is the standard from which we measure both heights and depths. Areas below this are under water and form parts of the Hydrosphere which has been dealt with elsewhere in this book ; while those above the sea-level form land which constitutes the continents.

Only about 30 per cent of land is above 3,000 feet above sea-level. The average height of the continent of Africa is about 2,200 feet, that of Asia is 3,300 feet and that of Europe is 1,100 feet. The following table (after Beckinsale) gives a vivid idea of the heights of land.

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[1] The heights and the depths when compared with the size of the earth are however, very insignificant.

Area in million sq. miles	Height
2	12,000, 18,000 feet and above
4	6,000 feet to 12,000 feet.
10	8,000 feet to 6,000 feet.
26	600 feet to 3,000 feet.
15	0 to 600 feet.

The chief land forms, *i.e.*, Mountains, Plains, Plateaus, and Valleys differ from one another (besides in their outward shape) chiefly in their altitude.

Most of the landforms are the product of more than one causes and geological forces. Most of the present landforms have been subjected to millions of years of weathering.

Varying erosion and rejuvenation complicate the comparatively older landforms. New landforms are being formed elsewhere with the material taken from older forms. Glaciation may over-ride all the surface features of a region, wearing off irregularities in some cases, while depositing an irregular heap of *drift* in others. A study of the landforms, therefore, should proceed with caution and with due regard to the above-stated facts.

1. **Mountains** are highlands having rather small top or summit areas. Their chief factor is their great height from the sea-level and their towering nature when compared to the adjacent plains or plateaus. They may be broadly classified as *young* and *old* mountains. The young mountains have usually not seen much of weathering and erosion and hence they are characterised by their great heights,high and prominent peaks, steep slopes and barren high surfaces. Because of their great heights, they are, as a rule, always covered by snow and glaciers are a common factor. Himalayas and Alps are good examples of such mountains.

On the other hand, old mountains have naturally seen ‘ time ’ and have been robbed of most of their ‘ glory ’ by the weathering agents. They are comparatively low and their slopes are usually gentle and their tops are ordinarily covered by vegetation. Streams have broader valleys and their velocity is relatively low. The Appalachains of North America and the Scottish Highlands are examples of old mountains.

According to their construction,[1] mountains may be sub-divided into (*a*) Fold Mountains, (*b*) Block Mountains (*c*) Volcanic Mountains, (*d*) Laccolith mountains (*e*) Residual Mountains.

(*a*) ***Fold Mountains.***—These are consequent to the folding (or wrinkling) of the earth crust into a succession of up and down wrinkles or folds. The upfolds or the ***anticlines*** form fold mountains while the downfolds or the ***Synclines*** form valleys that are known as ***longitudinal valleys*** (Fig. 42). The folding results from horizontal forces. Some fold mountains may be quite simple and symmetrical while others may present rather a complex view as is seen in the figure No. 51.

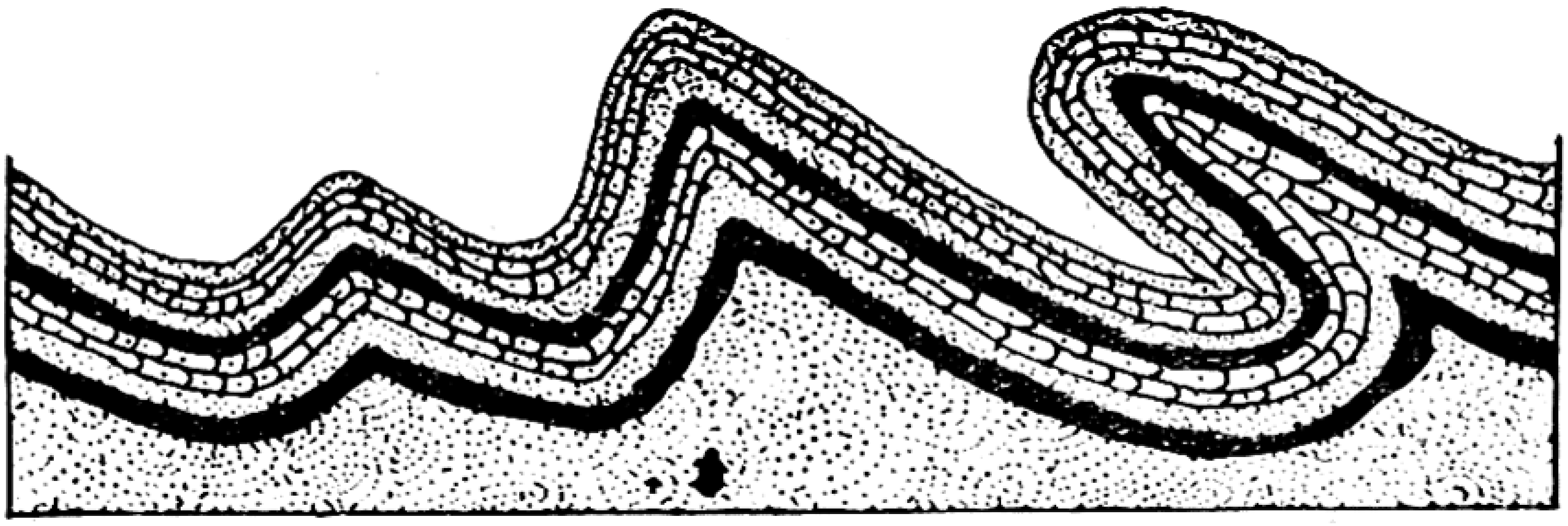

Fig. 51—Complex Folding (after Seeman)

The main streams flow in the valleys parallel to the ridges, while their tributaries flow more or less at right angles to the ridges. (Fig. 42).

The Jura mountains, the Himalayas and the Alps are examples of fold mountains.

The upholds (anticlines) are subject to the agents of denudation and in time may wear away. Sometimes they become so much eroded that they get lower than the valleys. This phenomenon as has been explained before in the section on rivers, is called the *inversion of relief*.

(*b*) ***Block-Mountains or Horsts.***—Sometimes the crust of the earth cracks owing to the vertical movements. Often

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[1] Geologically speaking the various types could be grouped as (*a*) ***Tectonic***, ***i.e.*** mountains which have resulted from the movements of the earth and (*b*) *Subsequent*, *i.e.* which are the result of erosion of other major land forms into mountains.

faulting also (*i.e.* the slipping down of portions on either sides or the upthrust of the central strata) occurs. The line along which the strata has slipped is known as a *fault*. The slipping may be anything from a few inches to many hundreds and thousands of feet. The Deccan plateau, Arabia and Meseta are examples of this type.

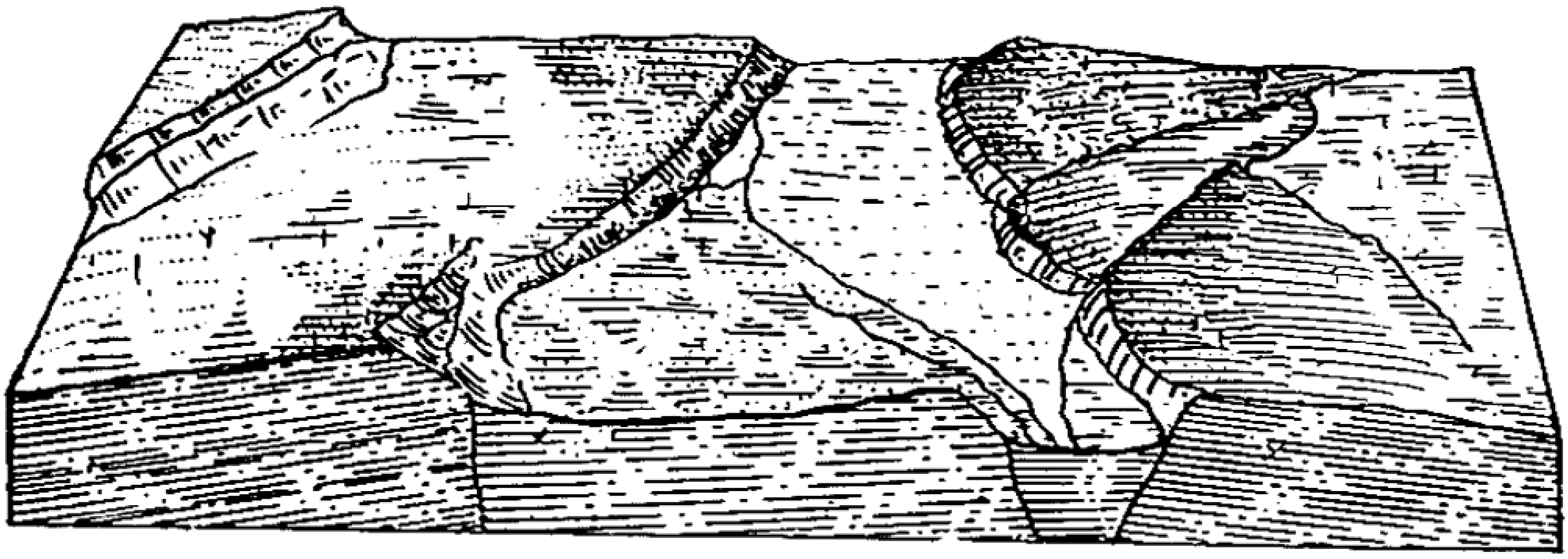

Fig. 52. Block mountains.

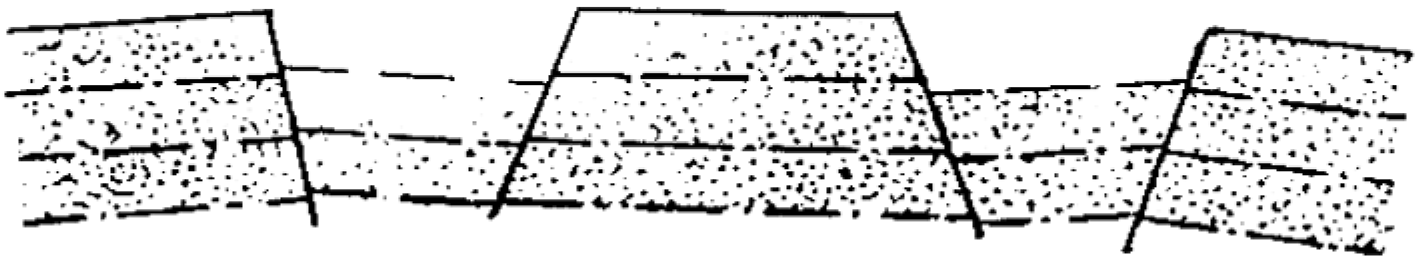

Fig. 53. Section of Crust Blocks. Also showing lines of faulting.

(*c*) *Volcanic Mountains.*—As the name signifies these mountains are accumulations of lava around a volcano. After some time, these accumulations assume great heights and form high mountains, *e.g.* Fujiyama in Japan. A detailed account of volcanic activity has already been given earlier.

(*d*) *Laccolith Mountains.*—Most of the lava or molten rock-material which has been forced up from great depths solidifies underground and never reaches the surface. This forceful lava intrusion from below may raise the overlying rock material in a dome-like shape—laccolith. Such land forms are only possible in such regions where the rock-material does not allow the lava to penetrate through it to the surface and is itself lifted because of its force.

(*c*) *Residual Mountains.*—These are also known as *Dissected Plateaus.* After a long spell of denudation, the softer portions of old mountain ranges are worn away, while the harder ones remain as plateaus or merely as peaks. Such mountain formations are known as *residual mountains.*

Man and Mountains.—Life in mountains is not so easy and not so very similar to that in the lowlands because of the different type of physical environment found there. Physically, mountains are not very suitable for occupations like agriculture because of the hard rock-material and the steep slopes. At certain places, however, terraces have been constructed and some cultivation is carried on. The question of mountain communications is also puzzling. Climate is largely affected by mountains. Temperature decreases rapidly with an increase in the altitude. Pressure also decreases. On account of the decreasing temperatures, rainfall lends to increase on the windward slopes and a rain-shadow lies on the leeward side because there the winds tend to descend and get warmer.

Some mountains are so high that after certain altitude there is perpetual snow and glaciers exist in high valleys. The line above which perpetual ice and show exist is known as the *snow line.*[1] Lower than this is an area which is too cold for any tree to grow. Hence the line above which trees cannot grow owing to decreasing temperatures is called the *Timber Line.* Between these two limits one usually comes across grass.

The question of rapid soil erosion is also to be faced by the mountain farmer and hence only a thin soil is available for agriculture.

Tree crops are, therefore, common because they are usually a source of permanent high yields both in the shape of timber and food. Fur-bearing animals are also hunted and trapped. Sheep and goats are kept in some of the grassy slopes and valleys.

Mountains are usually associated with mining, specially mining of inorganic minerals. Volcanic mountains are naturally more important for such concentrations. Many mountainous regions, therefore, possess large mining papulations.

The Mountain scenery and the invigorating climate of some of the mountainous regions tend to make them places of recreation and holidaying. In this respect easily accessible mountains are more important specially during summer months when increasing plain temperatures are not very much relished. In winters people flock there for winter sports.

In certain places, as in India, the present prosperity of the country is due to the existence of lofty mountain ranges. They not only act as barriers against foreign invaders but also affect the climate. Taking the case of India, the rainfall distribution and the favourable temperature conditions are due to the presence of the Himalayas and other ranges in the North. Whether the mountains are 'life-givers' depends more on their relative position. If mountain ranges surround an area, the state of affairs there is altogether different.

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[1] On the slopes facing the sun, snow is found higher than on those on the other side.

The presence of ice-fed rivers which contribute largely towards the economic prosperity of an area, depends solely on ice-covered mountains like the Himalayas and the Alps. And these rivers as is true of the Northern Plains of India and the Northern regions of Egypt, are the very life-blood of certain regions.

The presence and the distribution of passes have an overwhelming influence. They control not only the 'avenues of trade through mountains' but also affect settlements in certain areas. The Indian population has more inter-mingling of the Aryans and the Muslims than of the Tibetans, Burmese and the Chinese because of the presence of the Khyber, Bolan and other passes in the north-west.

Water power is another advantage more or less solely enjoyed by mountainous regions and their valleys and those lowlands that lie nearby.

In the beginning of this discussion we talked about poor means of communications in the mountains. Sometimes this disadvantage becomes definitely an advantage because in case of foreign invasions, it is easier to defend mountains. We have heard of Maratha guerrellas and how they were a source of trouble to the Moghal armies. To-day we are being told every day of the difficulties the Japanese are undergoing in the Chinese Highlands because they are unaccustomed to mountain fighting. The Greek and the Yugoslavian highlands are still a source of discomfort to the armies of Hitler.

2. **Plains.**—Broadly speaking, plains are the low flat lands of the earth. They are important because of their human use. Amongst all the landforms they occupy the largest area in space and support more than 75 per cent of the total population of the world and supply more than 80 per cent of our requirements in food and clothing. Because of their low elevation and flatness, agriculture is their main industry and because of the ease that they afford in communications, nearly all the trade centres are situated in them.

Geographically speaking most of the cxtensive plains (*e.g.* the great Siberian Plain and the Northern Plains of India) are situated in the Northern Hemisphere and constitute some of the most important economic regions of the world. In the Southern Hemisphere, the greatest plains (*e.g.* the Plains of the Amazon and the Congo) are situated near the equator and these are of little human importance.

Plains usually slope gently towards the sea and their height increases, sometimes considerably into the interior. Broadly speaking, plains may be divided as (*a*) interior or continental plains, and (*b*) Coastal plains. The very names of the two types clearly indicate their characteristics.

Plains also differ as to their mode of construction (or origin). Some are results of earth-movements, while others are due to accumulation, while still others may be due to erosion. As such, therefore, we may classify plains as under :

Alluvial Plains ; Delta Plains ; Coastal Plains ; Glacial Plains ; Lacustrine or Lake Plains ; Lava Plains and Plains of Denudation.

(1) *Alluvial Plains.*—These signify plains that have been constructed by rivers with the rock material or alluvium brought by them from the mountains. The Indo-Gangetic plain is an imposing example of this type. It is said that formerly it was a big trough and this depression was gradually filled up, by the northern rivers, into the Northern plain. Portions of these plains are subject to overflow during floods and such are called *Flood Plains.* To this type (*i.e.* alluvial plains) may also be added 'the outwash gravel plains' built by streams originating from glaciers.

(2) *Delta Plains.*—These are broadly an extension of No. 1. near the mouths of some rivers. Some details about the formation of deltas have already been given earlier in this chapter.

(3) *Coastal (or Marine) Plains.*—These means plains that were once below sea water. Their coming up and forming parts of continents may be due to the uplift of the continental shelf or to sedimentation caused by rivers and other agents of change. Remains of organic life in the ocean also contribute towards their formation.

(4) *Glacial Plains.*—These have been formed by glacial action. Occasionally glaciers spread out over somewhat undulating surfaces and gradually the depressions and valleys are filled to form an expanse of plains. At places these deposits are several hundred feet deep.

(5) *Lacustrine Plains.*—These were originally lakes and hence they are sometimes referred to as *Lake Plains* also. Sedimentation levels the lake bottom and after some time, it rises and the lake disappears and in its place we have a plain. Sometimes the lake persists and plains are formed only on the boarders, for instance, the level lands along the Great Lakes are Lacustrine plains, that is to say, that once they were parts of the lakes.

(6) *Lava Plains*—Such plains are as their name signifies, are due to lava deposits at the base of a volcano or around volcanic fissures and openings. Volcanic ash carried and deposited by rain water or rivers also levels the surface around a volcanic vent and a plain is built up.

(7) *Plains of Denndation.*—The formation of such plains simply involves the lowering of land surface by denudation. The original land may been a mountain or a plateau. Plains of Marine denudation which have been formed by the planing action of the surf attacking the coasts, may also be included in this type. A *peneplain* (almost a plain) is charactertic of the old age of river erosion and is the last stage in its cycle. A river deposits heavier material on the paneplain along its sluggish course. These longish heaps are called *natural Levees.*

3. **Plateaus.**—Plateaus are highlands with large 'flat summit areas'. There is usually an abrupt rise from the surface of the adjacent land to a plateau. The word *Tableland* expresses the significance very clearly. Ordinarily speaking a plateau means a mountainous or a hilly region whose rough tops and peaks have been weathered and valleys filled to give them a table-like appearance (Fig. 54).

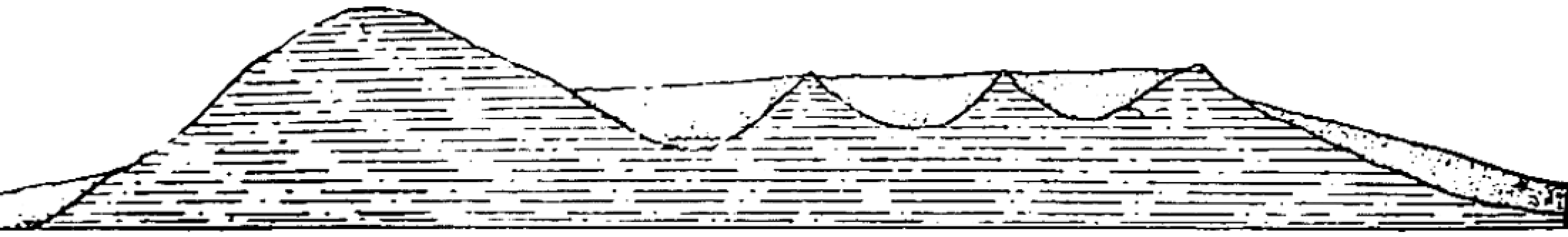

Fig. 54.—Sketch of a plateau. Dotted area shows deposited debris from mountains (after Seemen).

Plateaus are usually formed in the following ways :—

(1) Some have been formed by the accumulation of material on the earth surface either as deposits from other landforms or as lava deposits. These are known as *plateaus of accumulation.* The Deccan plateau of India was at places formed by the accumulation of lava deposits.

(2) Some plateaus are due to tectonic movements causing an uplift. The Colorado plateau is a good example of this.

(3) Some are the result of high areas having been warped down.

(4) Many plateaus result from a continuation of two or three of the above processes. That is while the plateaus detailed above are *Monogenic, i.e.* caused by a single process; this particular type is *Polygenic i.e.*, caused by a combination of more than one processes.

With favourable climatic conditions, plateaus are liable to support large populations. The Deccan is quite densely populated. The plateaus enjoy a cooler climate than that of plains in tropical latitudes and hence people flock there for temporary residence if not for permanent settlement. In places of good rainfall, agriculture is carried on successfully but in drier regions, grazing is the chief occupation and population is comparatively sparse.

4. **Hill lands** :—Hill lands are ordinarily 'subsequent land forms' left by the agents of change in mountains, plateaus and plains. They are, therefore, of little or no importance to the geologist but we as geographers, are interested in them as they have a direct effect on human activities.

This typical landform is characterised by a slight summit area and slight relief. Dissected plateaus sometimes give appearance more of hill lands than plateaus. The foothills of mountains may also be included in this category because they have none of the magnificence enjoyed by mountains.

There is great similarity between the human activities in hill lands and mountains, except for the difference substantiated by the difference in altitude, Forests or pastures, depending on the amount of rainfall received, are the usual features of hill lands. At places cultivation is also carried on but this leads to a rapid erosion of the soil with subsequent decrease in yield. Lumbering, farming and stock-raising are therefore, some of the most important occupations followed therein. Mining and following this manufacturing are also carried on in many places. Most of the people live in the valleys or on the crests.

5. **Valleys** :—A valley may be defined as a 'narrow strip of almost level ground from which the land rises up on either hand.' The rising sides are the *valley sides* and the level ground in between is called the *valley floor*. The various types of valleys and their formation have already been referred to during the sections on rivers, glaciers and mountains. Here it may suffice to assemble those facts briefly and in a systematic manner.

Valleys[1] may be broadly divided into two types, *i.e.*,

(*a*) *Tectonic valleys* or valleys caused by earth movements—and

(*b*) *Valleys of erosion.*

(*a*) *Tectonic Valleys* :—Amongst these we include *rift-valleys* (Fig. 55) due to faulting and *synclinal* or *downfold valleys* (Fig. 42) due to folding. The Irrawady and the Yangtse Kiang occupy long synclinal valleys.

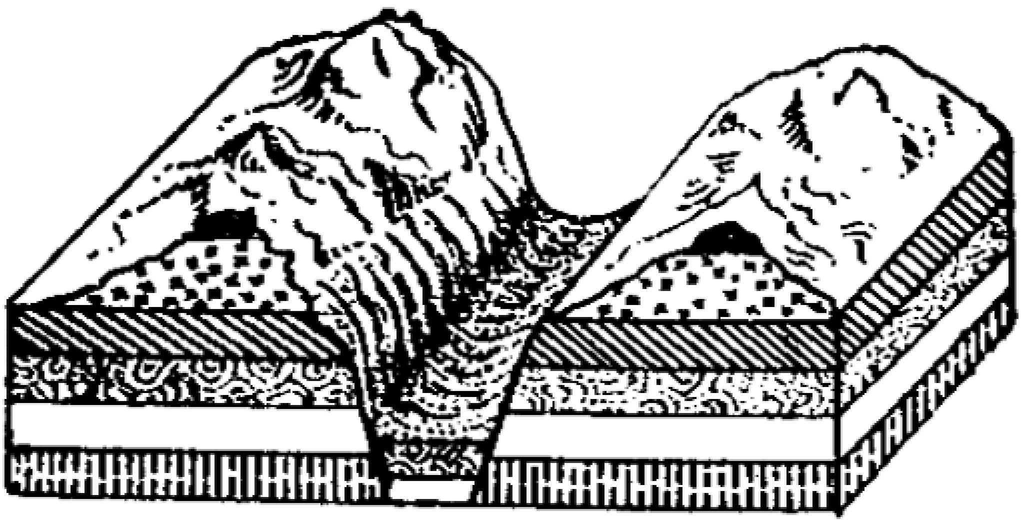

Fig. 55. A rift-valley.

A rift- valley is formed betweeen two parallel faults and also by downward sinking of rock strata (Fig. 56) These are also called *Trough valleys* or *Fault valleys*. The Rhine occupies a magnificent rift-valley. The Lowlands or the central valley of Scotland is another example.

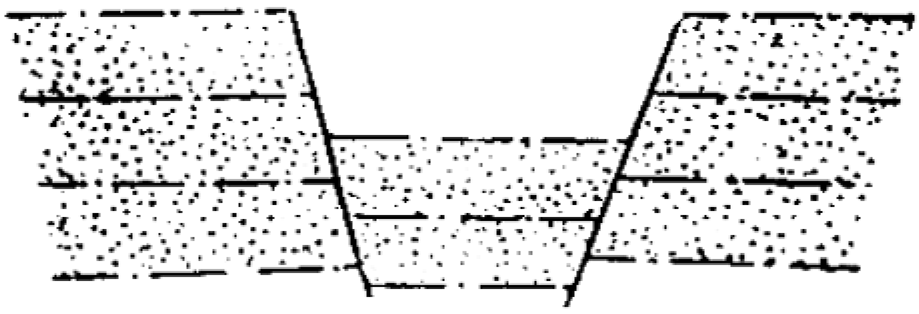

Fig. 56. Section of a Rift-valley also showing faults.

(*b*) *Valleys of erosion* :—Under this head we may include the V-shaped valleys caused by rivers and the u-shaped valleys cut by glaciers. The canons and the gorges (also known as I-shaped valleys) deeply cut by rivers in horizontal strata are also minor members of this type. They are called I-shaped because of their narrowness and their great depth. The difference between a gorge and a canon is that a canon is a gorge on a large scale. The Colorada in U. S. A. and the Kistna in India have cut deep canons in their respective mountain chains. The Indus has cut a series of traverse gorges in the Himalaya and same is the case with the Yangtse Kiangs. A *traverse gorge* means a gorge cut across a mountain ridge.

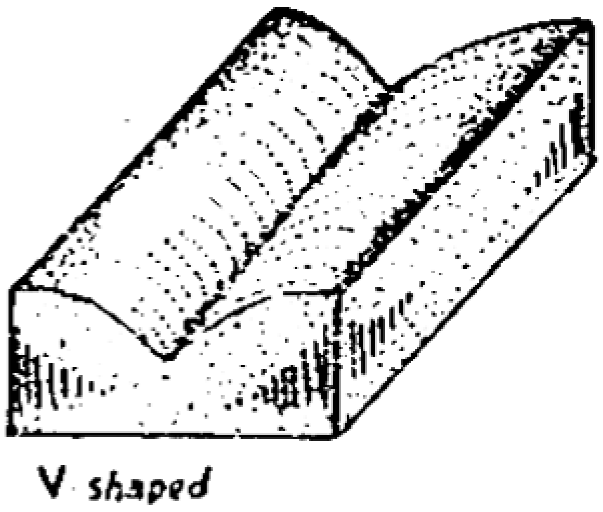

Fig. 57. V-shape valley.

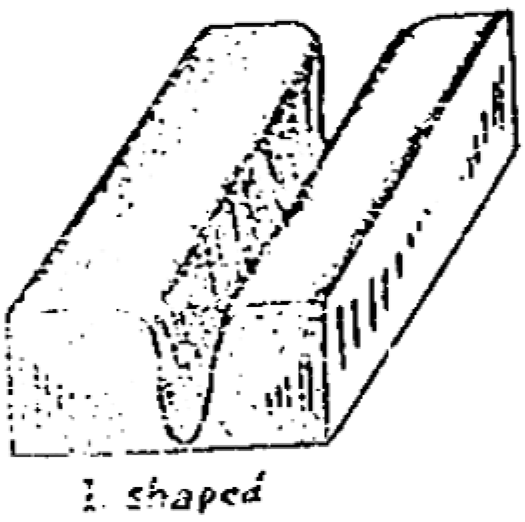

Fig. 58. Canon or I-shaped valley.

Anticlincal valleys are carved on the summits of anticlines by weathering agents. Soon a stream may also develop. The Appalachians and the Jura mountains abound in examples of such valleys.

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[1] A basin is a big valley (both longer and broader.) A big basin is sometimes called a *river plain*.

Lakes :—Lakes may be defined as bodies of water[1] (big and small) occupying enclosed depressions in the land surface. Their basins are only local depressions and technically speaking 'lakes are a phase of drainage.' A lake of a very small size is called a *pond* and artificially-made lakes are called tanks. Lakes and ponds are ordinarily quite cut off from seas and oceans.

Lake-formation is due to a number of causes. Based on their origin, lakes may be divided into the following types :—

(1) *Raft lakes* are formed by the damming of rivers by slides and various types of rock and organic deposits. Rivers may also be dammed by wind-blown sand, lava flows and ice. Such obstructions, however, are only short-lived and very soon the rivers find other escapes. During floods also, some of these temporary lakes lose their identity.

(2) Some lakes are only '*relics* of comparatively recent seas'. Caspian and Aral seas may be cited as good examples of this type. The cutting off of the seas may be due to earth movements or sedimentation.

Small shallow lakes also occur in some of the recently uplifted sea coasts.

(3) *Tectonic Basin-lakes* are, as their very name signifies, due to mountain-building and other earth movements. They are typical of rift-valley regions and crust blocks. The Dead Sea occupies a fairly deep depression in the great Nubian rift-valley of Palestine.

(4) *Glacial Lakes.*—These also include *Morainic Dammed* lakes *i.e.*, lakes formed by the damming of valleys by morainic material. Glacial lakes are also due to unequal glacial erosion. Some lakes in North America were made by a combination of both the above processes. The lake district in England owes its beautiful lake landscape to glaciation.

(5) *Mountain Ribbon or Glen Lakes* :—These naturally are 'long, narrow and usually very deep.' River denudation and glacial action combine to carve these lakes in mountain regions and they are independent of earth movements. Many lakes in the Alpine region of

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[1] Caspian Sea which is technically a lake covers an area of about 170,000 sq. miles, while the Nainital lake in U. P. hills hardly occupies an area of about ⅓ sq. mile.

Europe fall under this type. *Rock Tarns* is the term used for smaller lakes of this category.

(6) *Volcanic lakes* :—This type of lake formation is due to volcanic activity. Sometimes a lava stream obstructs the flow of a river and a lake is formed. A number of craters of extinct volcanoes are occupied by circular lakes of great depths. Lake Avernus near Naples in Italy is the best example of this type. The Crater lake in Oregon (U. S. A.) is another example. It has a diameter of five and a half miles and is about 2,000 feet deep, being situated at a height of more than 6,000 feet.

(7) *Solution lakes* :—When rivers flow over limestone districts, they dissolve the limestone and occupy vast but shallow and irregular expanses of land. These are called *Solution lakes.* Good examples of these are found in Ireland where the river Shannon flows over large limestone expansions.

(8) *Ox-Bow lakes* :—Ox-bow lakes are crescent-shaped bodies of water and are caused by the meandering action of rivers. The figure shows how a river leaves behind its old circular meanders that are known as ox-bow lakes. Some details about this topic have been given in the section on rivers. Also see Fig. 41 where 6 depicts an ox-bow lake.

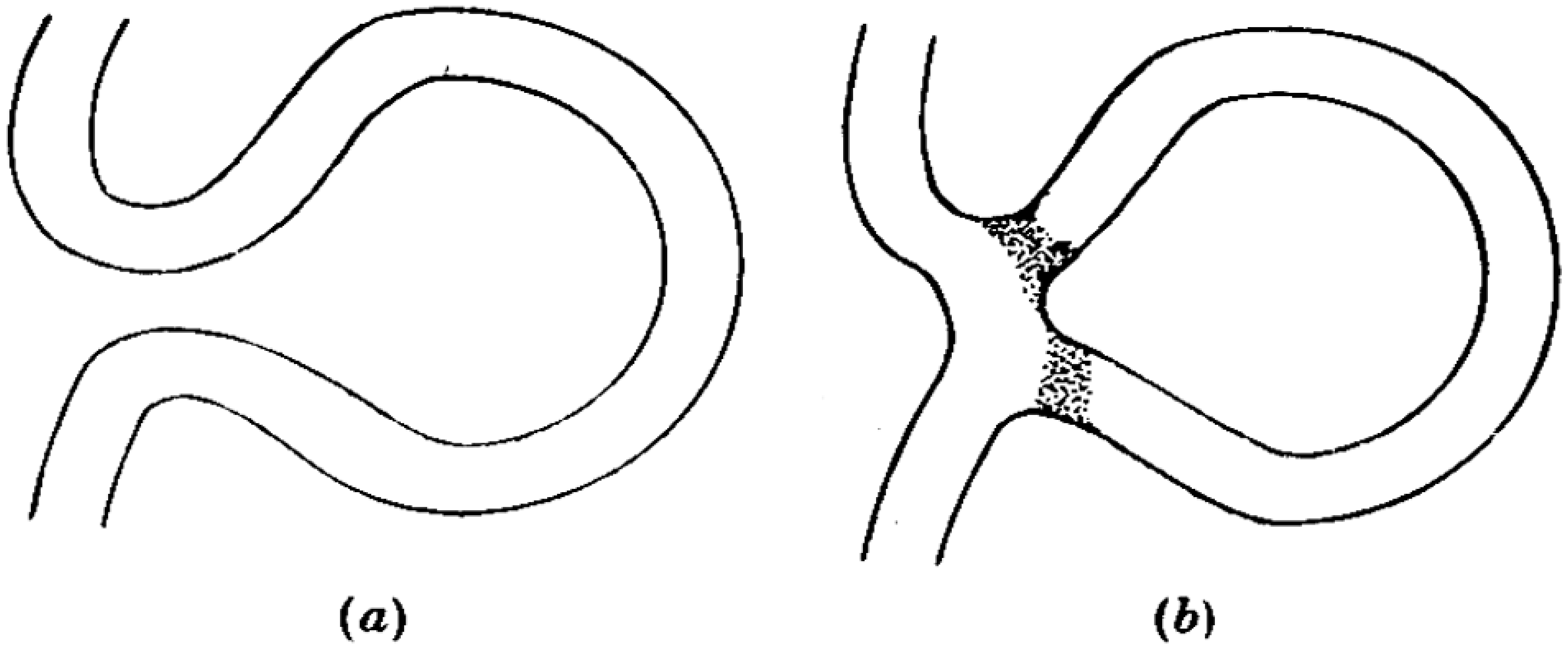
(*a*) (*b*)

Fig. 59. Shapes in the formation of an Ox-bow lake.

General remarks about lakes and their utility to man :—Lakes are not permanent features of the earth surface and their life is usually short, *i.e.*, geologically speaking. Lakes that get rivers are very soon filled with sediment. Small lakes in hot regions are liable to be dried up.

Lakes are instrumental in controlling the flow of rivers specially during floods and thus they save a loss of life and property. By causing them to deposit their silt, lakes work as filter for rivers passing through them.

Lakes also supply neighbouring regions with water for domestic and irrigational purposes. In many places artificial water reservoirs have been constructed.

Big-sized lakes like the Great Lakes of North America are used for commercial and passenger transport.

Many lakes provide excellent fishing grounds and many supply abundant electric energy.

Lakes also add to the scenic view specially in mountainous regions.

Vast sheets of water also exert a remarkable influence on the climate of the surrounding areas. This tempring influence is similar to that found on sea-coasts. The Great Lakes of North America not only affect the temperature conditions favourably but also supply abundant water-vapour to the air, and thus increase local rainfall.

CHAPTER III

(HYDROSPHERE)

The Water Surface

The vastness of the water expanses on the surface of the earth is difficult to comprehend. More than 71 p.c. of the earth's surface is covered by water. The following table gives the distribution of water for every 10 degrees of latitude.

Degree of latidude	N. Hemisphere	S. Hemisphere
0	...	77 p. c.
10	79 p. c.	76 p. c.
20	63 p. c.	78 p. c.
30	58 p. c.	77 p. c.
40	49 p. c.	89 p. c.
50	44 p. c.	97 p. c.
60	30 p. c.	99 p. c.
70	71 p. c.	85 p. c.
80	95 p. c.	27 p. c.
90	...	..

81 p. c. of the Southern Hemisphere is covered by water. About 57 p. c. of the total water area is situated south of the equator.

Ocean floor :—The ocean floor like the surface of land is not 'very irregular,' the deepest point (Mindanao Deep) being 35,400 feet deep. About 70 p. c. of ocean floor has a depth of about 10,000 feet. The average depth of the Atlantic ocean is about 11,000 feet, and that of the Pacific ocean is about 13,000 feet. The inequalities of the ocean floor are really very insignificant when compared with the area of the globe but for us, human beings, even these small inequalities are full of significance.

The ocean floor has many irregularities consisting of 'basins' and 'rises'. These basins and rises are usually very large in size. The great rises[1] compare favourably in size with Africa or South America. The basins that surround the rises are also of equal vastness. Besides, there are some other features of the ocean floor, *e.g.*, valley-like depressions, steep slopes, volcanic cones and ridges.[1] The ocean floors are covered with fine, 'soft clay-like substance' called '*ooze*.' Attempts have been successfully made to draw the 'contours' of the ocean floor. Technically these contours are called *Isobathic contours*.' The greatest depths are not situated in the centre of oceans but are located near the bordering lands. Ordinarily the 'contours' have a steeper gradient on the continent side and a more gentle slope towards the oceans.

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[1] Such as the Mid-Atlantic rise and the Easter Island rise.

The edges of the land masses are covered with shallow water under which lies the *continental shelf*. It really is the extension of the continent now covered by water less than 100 fathoms deep. For mankind continental shelf is the most important part of the ocean (specially for fishing). The width of the continental shelf varies from place to place.[2] As a rule a mountainous coastline has a narrow continental shelf. Ordinarily the slope of the shelf is gentle, but as soon as the 100 fathom line[3] is crossed, the descent gets abruptly steeper.

Island.—Islands are of two types: (*a*) Continental ·islands and (*b*) Oceanic islands.

(*a*) *Continental Islands* are those which like Ceylon or British isles, were some time back parts of the continent near which they are now situated. Rocks and scenery in such islands resemble rocks and scenery of the adjoining continent. There is also a general similarity between the plants and animals of the two places, though the number of species on the main land is far greater.

'*Wallace's line*' that runs between the islands of Lombok and Bali in the East Indies, is perhaps, the most interesting line of separation between two continents. The animals of the islands on one side of the line belong to the Asiatic group while those on the other side belong to the Australisian group. Even the animals on the Bali and Lombok islands which are situated close to one another, have no resemblance whatsoever—a fact that proves that the separation must have taken place very long ago.

Oceanic Istands.—These are usually situated away in

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1. The bottom of the sea is not sharply rough and uneven; and unlike the land, it is comparatively flat. The reason is that the agents of erosion do not affect it as they do in the case of land.

2. The continental shelf around British Isles varies from 30 miles to 200 miles in width

3. This line (known as the 'continental edge') marks the original coast line.

the ocean and are of an independent origin, having never been connected with any continental mass. Oceanic islands may be further sub-divided into (*a*) Volcanic islands, and (*b*) Coral islands.

(*a*) ***Volcanic Islands*** are ordinarily summits of volcanoes (many of whom are still active) built up on the ocean-floor. Plants arrive in these islands as seeds blown by the wind or carried by birds, etc.

(*b*) ***Coral Islands.***—In the warm salt waters of the Tropical seas, coral is found living in huge colonies specially off the eastern coasts. When they die, their skeletons form a compact rock on which new creatures live, and eventually huge masses of 'coral rock' are formed rising above the water surface. They are known as 'Coral Reefs' or islands as the case may be.

Coral formations are not entirely made of corals. There are some other organisms that play equally important parts in their formation :

Three types of coral reefs are usually recognised :

(*a*) If the reef lies parallel to the shore of some land mass, separated from it by a stretch of shallow sea (lagoon), it is called a '*Fringing Reef.*'

(*b*) If the 'lagoon' *i.e.*, the sea in between is quite deep and wide, the reef is termed a '*Barrier Reef*'. The great Barrier Reef of Australia is the most imposing example of this type.

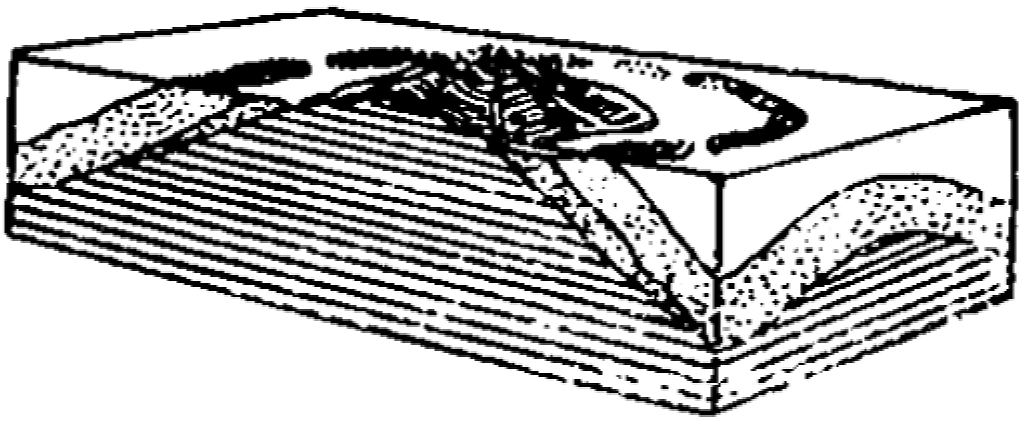

Fig. 60.—A Barrier Reef.

(*c*) If the reef assumes the shape of a ring or horse-shoe with a piece of shallow sea in the centre, it is called an '*Atoll*'. These atolls are normally about 15′ above the sea-level, but many of them are inhabited and covered with vegetion specially coco-nut palms.

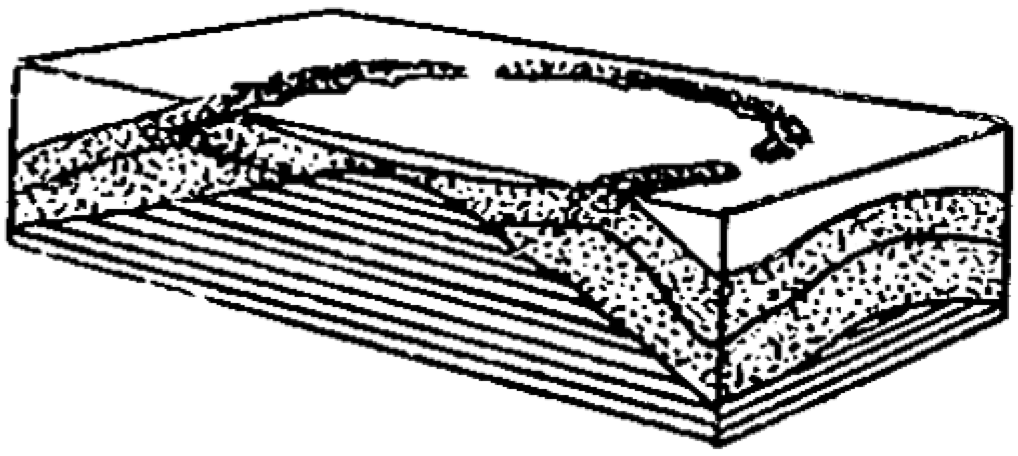

Fig. 61.—An Atoll.

If the reef is wide, sand collects on the coral flat, thus forming 'islands'. Such islands are usually low in elevation. As time passes, plant seeds, animals and birds find their way to these newly-formed islands. The best examples of coral islands are the Bermudas and the Bahamas lying in the northern half of the Atlantic Ocean.

The Salts of the Sea-water.—About 4 pounds of dissolved mineral matter is found in every 100 pounds of sea-water. More than ¾ of this matter is common salt, but nearly all other substances found in the earth's surface are present in small quantities. The percentage of the main components are detailed below (as quoted by Beckinsale) :—

Sodium chloride (common salt)	77·8	p.c.	of Mineral	Matter
Magnesium chloride	10·9	,,	,,	,,
Magnesium sulphate	4·7	,,	,,	,,
Calcium sulphate	3·6	,,	,,	,,
Potassium sulphate	2·5	,,	,,	,,
Calcium carbonate	·3	,,	,,	,,
Magnesium bromide	·2	,,	,,	,,

The great amount of common salt is had by the solution of rocks in contact with the sea and from muddy river water.

The chief mineral now derived from the sea is salt. On many islands salt production is the chief occupation. Nearly all of the salt beds found on land are said to be old salt-lake beds which have been cut off from the sea by evaporation or by variations in the surface level. Such important beds are found in Australia and Poland.

Costly experiments have revealed that many other substances like gold and silver can also be had from sea-water. A cubic mile of sea-water, it is said, contains about "3 million dollars in gold and 8½ millions in silver." But the methods, as yet, are far too expensive.

The salinity of the sea-water, however, differs from place to place. Generally speaking the salinity of the Tropical waters is greater than that of the Polar waters[1]. Salinity at the surface of any portion of the ocean depends largely on the rate of evaporation, rainfall, the presence of fresh river water and ocean currents.

High salinity is found in areas of great evaporation specially in enclosed seas. Dead sea water possesses about 235 parts of dissolved salts per 1,000, while the salinity of the partially enclosed Red Sea, is 41 per thousand only.

In regions of heavy rainfall, *e.g.*, in the Equational region the surface salinity is rather low inspite of the heavy rate of evaporation. While in regions near about 30° N and S, rainfall being low and evaporation more or less equal, salinity is comparatively higher. The surface salinity in the higher latitudes is also low because of the small amount of evaporation.

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[1] 87 per 1000 parts in the Tropics and about 80 and less in the Polar regions.

Salinity of enclosed seas like the Baltic Sea, is low because of the river waters that are always being added to the sea water. At places in the Baltic sea, salinity is as low as 2 per thousand—the maximum being 8 per thousand.

Salinity of surface water is being continuously altered because of climatic factors. Waters of higher salinity are denser and are always replacing those which are lighter owing to the presence of small amount of salts. This causes a regular slow movement of sea-water (partly horizontal and partly vertical).

Temperature of oceans.—The temperature of the surface layers of ocean waters varies from latitude to latitude in the same order as on land, but at greater depths *i.e.*, below about 5,000 feet the temperature is more or less uniform every where *i.e.*, about 30°F in high latitudes and about 35°F within the Tropics. The surface temperatures are between 80°F and 90°F near about the equator and about 30°F or even less in Polor regions. In enclosed tropical and subtrocial seas (*e.g.*, the Gulf of Mexico), the temperatures are somewhat higher than those in open oceans and seas in the same latitudes; but in the higher latitudes just the reverse is the case, *i.e.*, the waters of open oceans are warmer. Currents also affect surface temperatures.

The sun's rays have little effect on sea-water below 5000 or 6000 feet, hence the temperature below this depth is more or less uniformly low everywhere. Only where the ocean floor rises to a *sill*. (or barrier not very far below the surface) that cuts off a sea from the rest of the water mass, we come across high temperatures even at the bottom of the sea. The sill prevents cold, denser water of the ocean from entering the sea. A good example of this is found in the Red sea the temperature of whose bottom is even higher than 70°F, while those of the Indian ocean decrease with depth to under 35°F.

Movements of the Ocean.—Sea waters are never still. Widespread movements are continually taking place in it. They may be classified as below :—

(*a*) *Waves*—Waves are due to the wind. Water simply rises and falls but it does not move forward. The size and the magnitude of waves depends on the force of the wind. When the winds are strong, they are dangerous for navigation. Wave motion is only limited to the surface of the sea.[1]

The highest part of the wave is called the 'Crest' and the lowest part the 'Trough.' The distance from trough to trough or from crest to crest is termed as the 'length of the wave' and it is often about a quarter of a mile. The vertical height of the crest is called '*amplitude*' The maximum height of a wave is never more than about 48 feet, but naturally for a ship lying in the trough, it looks exaggeratedly terrible.

Waves are formed into *breakers* when they meet a shelving shore or a hidden reef.

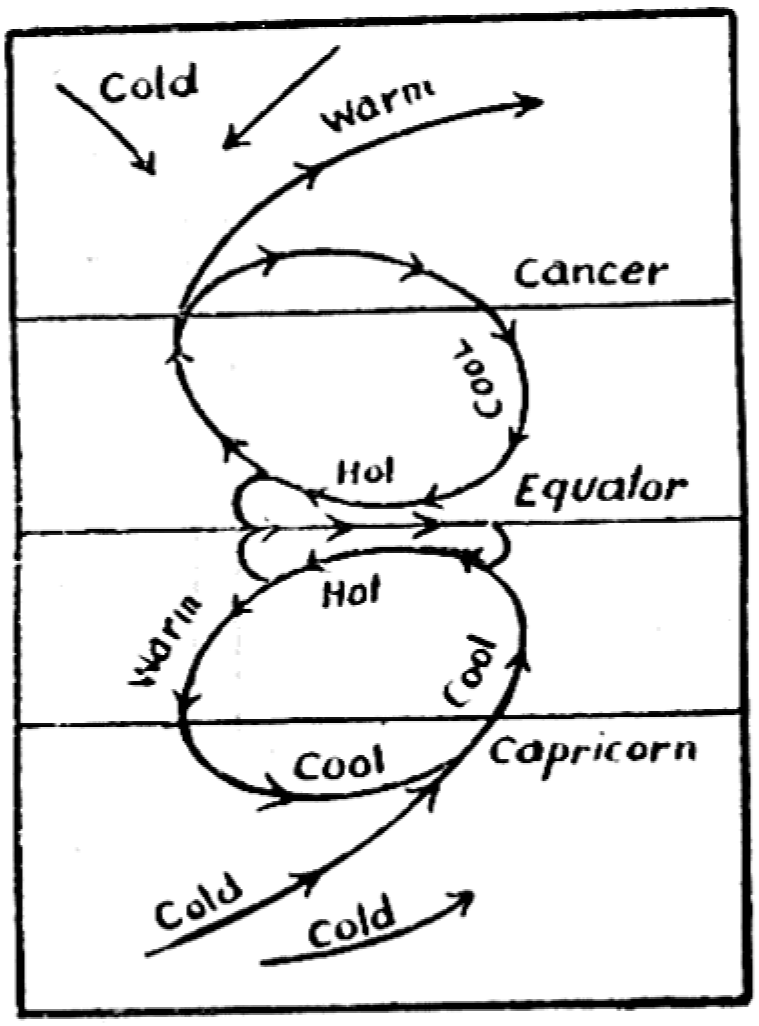
'Swells' are low, long waves which are observed with the approach of a distant storm or after the dying down of a past storm.

(*b*) **Ocean currents.**—Currents are by far the most important element in determining the distribution of Marine life and in the distribution of ocean temperatures.

Generally speaking the currents are moving rivers in ocean. They move at the average rate of 2 miles an hour.

The two chief causes of the circulation of ocean waters in the shape of currents are (*a*) the influence of the strong planetary winds and (*b*) the difference in the density of the sea-water itself.

(*a*) *The movement of the winds* causes a corresponding movement in the ocean waters. The strongest movements are caused by the Trades as they are the strongest winds. On either side of the equator, the N. E. and S. E. Trades bring about a westward movement of ocean waters thus causing what are known as equatorial currents. (Fig. 62). The currents are deflected northwards and southwards by the continents. These equitorial currents are warm currents and have a corresponding effect on the



THEORETICAL CIRCLATION OF OCEAN CURRENTS

Fig. 62,—(Read circulation for circlation.)

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[1] A submarine can avoid a storm by diving, for at a depth of about 100 fathoms, it is quite calm.

places they pass by. The figure 68 shows the world distribution of cold and warm currents.

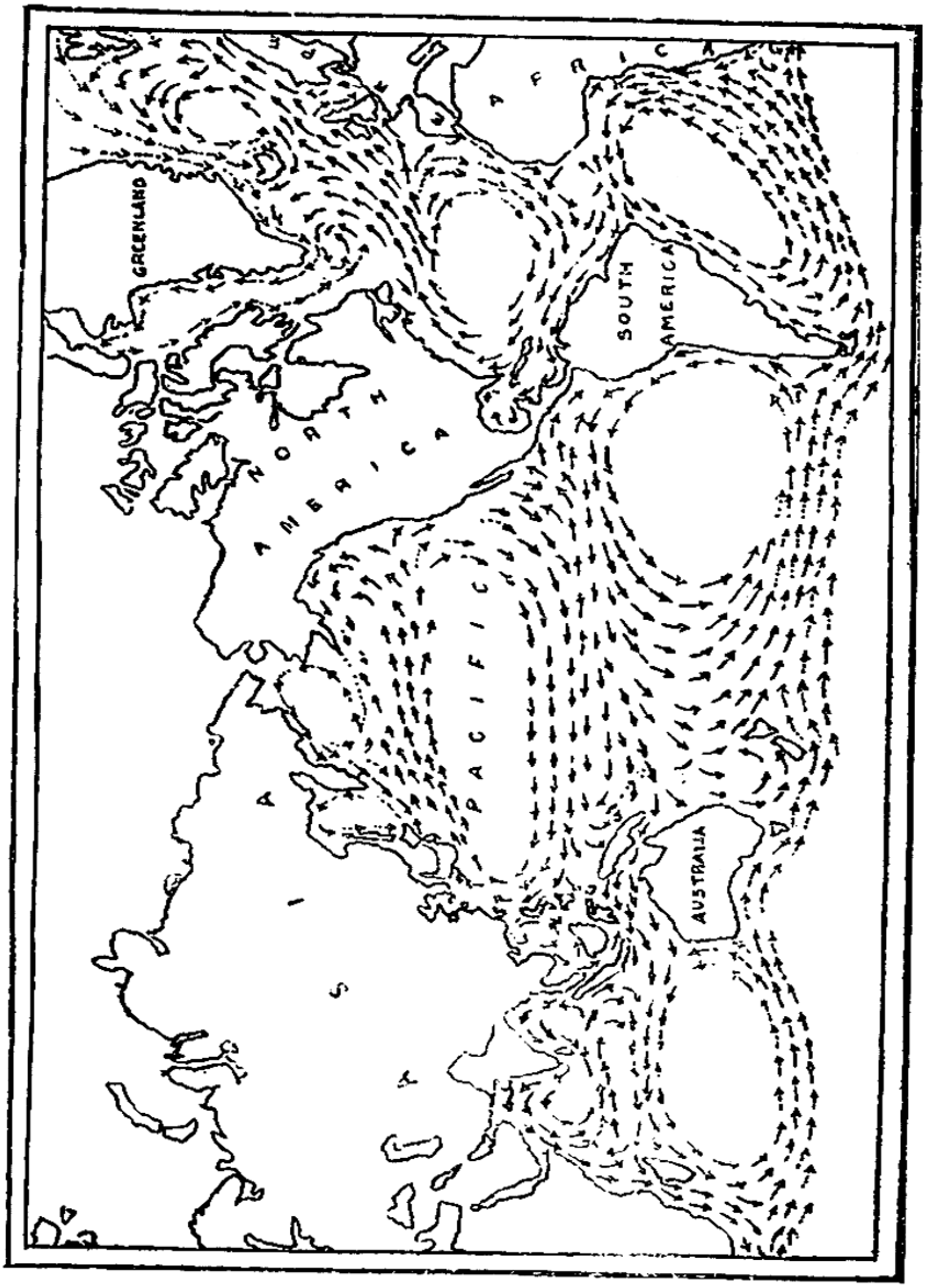

Fig. 68.—Currents. (Broken arrows show cold currents.)

Let us follow the course, just by way of illustration, of the Gulf Stream, perhaps the most important warm current in the world spreading its influence far and wide. Notice in the figure that the obtruding portion of eastern Brazil[1] in South America divides the southern half of the Atlantic equatorial current in two parts—one going northwards and joining the North Equatorial current into the Gulf of Mexico, and the other going Southwards as the Brazil current.

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[1] Cape Saint Rougue.

When the north equatorial current emerges out of the Gulf of Mexico, it begins to be called the Gulf Stream. It is one of the biggest currents in all respects.[1] But as it moves northwards through the Atlantic, it loses much of its magnitude. The eastern shores of U.S.A. upto Cape Cod are under its moderating influence.

In the westerly wind belt, the Gulf Stream is driven eastward and is known as the Atlantic Drift[2].

In the eastern waters of the Northern Atlantic, a part of the current turns South, while the second part passes North Eastwards into the Arctic ocean past Norway. The current has a marked effect on the prevailing winds of the region with a consequent effect on the temperatures of the Atlantic shores of the European continent. The most striking example is Norway whose temperature is much higher than of places situated in corresponding latitudes in the interior of the continent.

Since the equatorial currents pour their waters into the Arctic and the Antarctic oceans, return currents are caused. These are cold currents because of the cold origin and hence have a corresponding influence on regions they pass by. These currents cause fog when they meet warm currents or when warm winds reach them and are cooled. This fog is of great danger to navigation. The ice-bergs which the cold currents usually bring with them are also a source of danger to shipping.

(*b*) *The difference in density* may be caused by contrast in salinity or temperature. Denser waters move to replace lighter waters. Not much data, however, is available on these points, but it is a general opinion that the difference in temperature plays a more important role in the circulation of water than contrasts in salinity.

Modern science has invented a *current meter* which records the velocity and the direction of currents quite correctly.

It may be useful to give, in a summary form, the names, locality and nature of the various ocean currents

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[1] Average width 40 miles to 100 miles; average depth about 200 feet and average Velocity about 5 miles an hour.

[2] Here it broadens considerably.

(consult a good Atlas along with the map given in the book) :—

(*a*) *Equatorial currents* occur in all the oceans near the equator and flow from east to west. Had there been no continents to block their westward progress, all the currents would have combined into one very broad current that would have gone round the world. But as things stand these equatorial currents turn North and South and give rise to coastal currents.

(*b*) North Atlantic :—

Cold currents :—
- (*a*) Labrador.
- (*b*) Canaries.

Warm currents —
- (*a*) Gulf Stream and North Atlantic Drift.
- (*b*) North Equatorial.

(*c*) South Atlantic :—

Cold currents :—
- (*a*) Patagonian
- (*b*) Benguella.

Warm current :—Brazilian.

(*d*) The Pacific Ocean :—

Cold currents :—
- (*a*) Californian.
- (*b*) Kamchatka.
- (*c*) Antarctic.
- (*d*) Peruvian.

Warm currents :—
- (*a*) Kuro Sivo (going along the coast of Japan and across to North-West America).
- (*b*) East Australian.
- (*c*) North-Pacific Drift.

(*e*) South Indian Ocean[1] :—

Cold currents :—
- (*a*) Antarctic.
- (*b*) West Australian.

Warm :—Mozambique.

The equator divides the curents into two more or less similar and parallel current systems. It is important for you to study the currents of the two hemisphereses respectively. This you may do with the help of the given map or from any atlas map showing currents.

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[1] North of the equator, the Monsoons change the directions of currents During North East Monsoon, the North East current comes into evidence, while during South West monsoon the direction changes to South West.

Tides.—We have already learnt that all the heavenly bodies have attractive forces that are being exerted on other bodies. Force of attraction decreases inversely as the distance increases. The moon is the nearest heavanly body, hence its attraction is the greatest on the earth; sun's attraction taken separately is insignificant owing to the great distance between the sun and the earth.

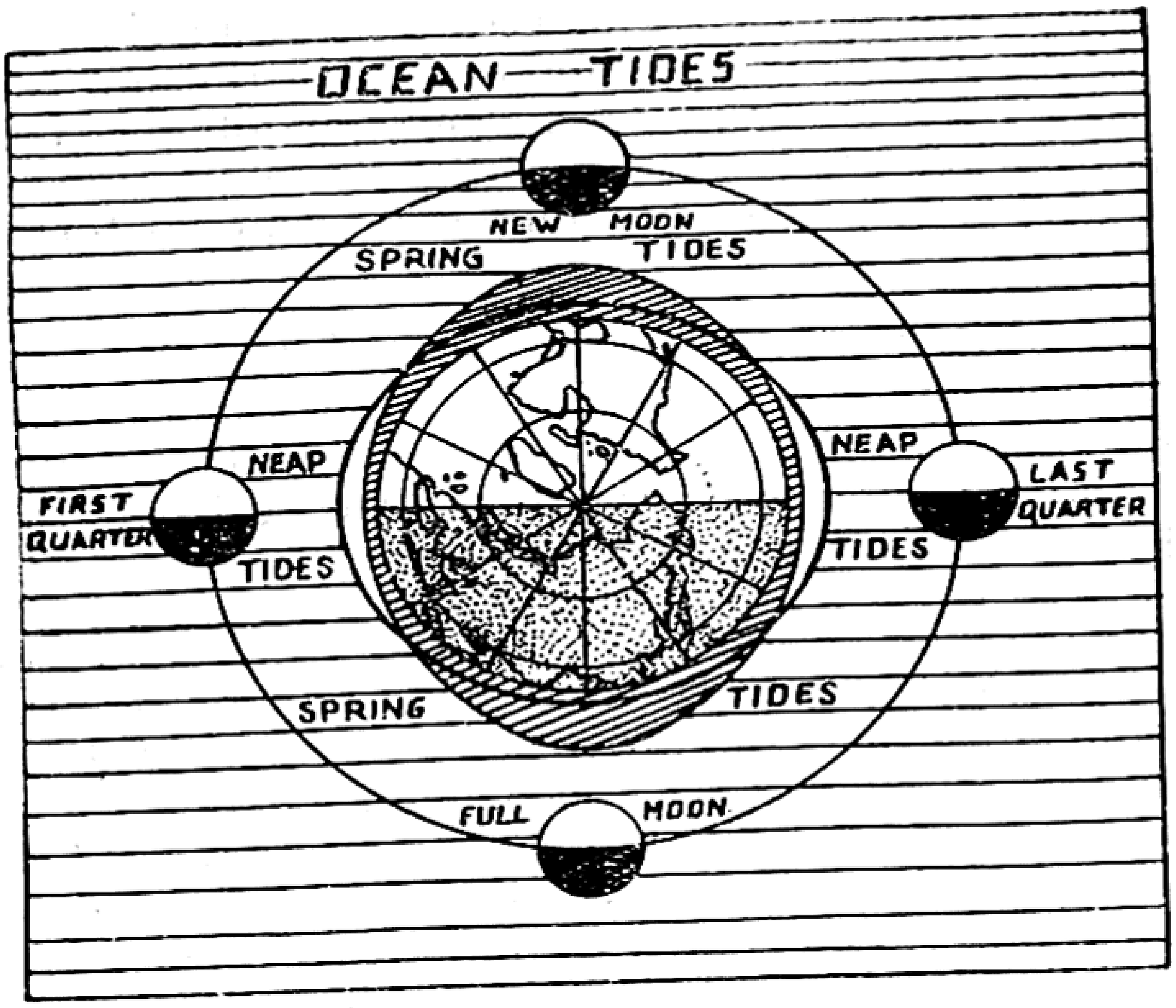

Fig. 64.—Tides. The black line represents Neap Tides and the black shadding shows Spring Tides. (After Goodall).

The waters of the oceans are also attracted by outside bodies more particularly by the moon because of its relative proximity.

The force of attraction between the moon and the water on the face of the globe turned towards it, is greater than that between the moon and the solid earth beneath it, because the solid earth is farther away. Hence the waters on that side are pulled away from the earth. Similarly the earth is pulled away from the water on the opposite side. The result is that waters are heaped on the opposite sides of the earth (Fig. 64). On the other two sides water gets low. This rise and fall of ocean water caused by the attraction of the moon is known as 'Tides'. Owing to the relative motions of the earth and the moon, there is created a tidal wave round the world. The whole hydrosphere experiences one low and one high tide every 24 hours. The normal direction of tidal motion is from east to west but the actual directions are modified by the presence of land masses. In any one locality the moon rises 50 minutes later than on the previous day, the high and the low tides also occurring correspondingly later.

Spring and Neap Tides.—The sun also influences the tides although the force exercised by the moon is about 2¼ times more than that of the sun.

When the sun and the moon are in conjunction on one side of the earth, *i.e.* at new moon or when the sun is on the opposite side at the full moon, the pull of the moon is supplemented by that of the sun, and high tides (called *Spring Tides*) occur. This phenomenon occurs at fortnightly intervals.

On the other hand, when the sun's attraction and the moon's attraction are exerted at right angles to each other, they partially neutralize one another. This happens at the 1st and 3rd quarters. At these two positions tides are relatively low and are called *Neap Tides.*

In the open seas and oceans, the difference between high and low tides is merely a few feet, but on continental shelves and in other shallow waters, the rises and falls are considerable. The flow of water, which results from high and low tides in harbours and river-estuaries, helps to eradicate sediment which would normally be deposited therein. In narrow-estuaries, high tides come in as a ' wall of water, ' known as a '*Bore*' The tidal walls of the Bay of Fundy help shipping in that region. In almost enclosed seas like the Mediterranean, the tidal range is only about 2 to 3 feet.

Tides are of great importance to commerce, as the high tides enable ships to reach harbours and docks which would be inaccessible to them if the water remained at its average level.

The possibility of utilizing the energy of the tides for the generation of electric power is often mentioned. Tide mills run by the ebb and flow of tides are already in use.

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[1] Here the difference between high and low water is as much as 70 feet, while in the narrow estuary of the Severn it is about 40 feet.

CHAPTER IV

ATMOSPHERE

(1) General Principles

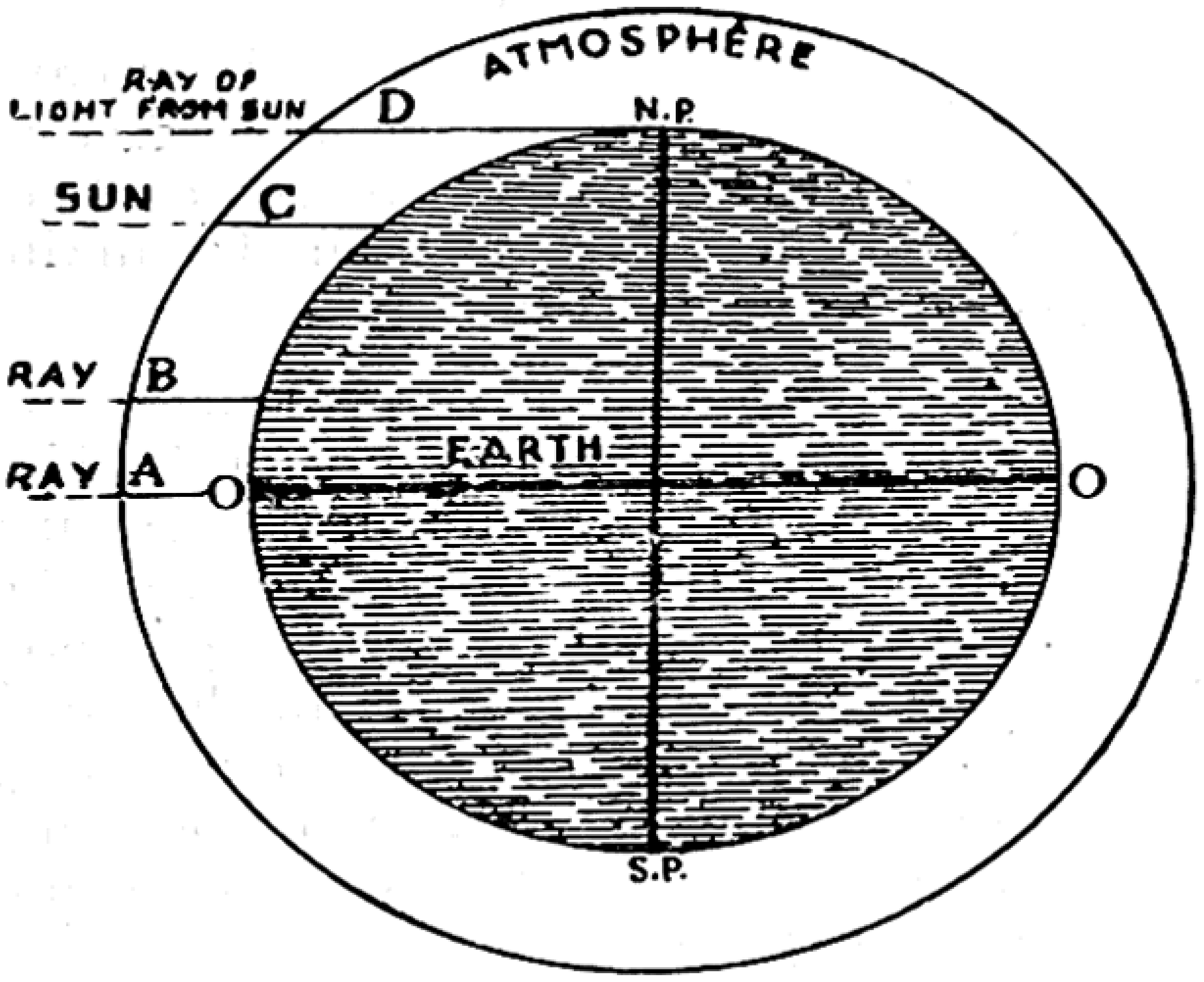

Fig. 65. Atmosphere and the rays of the sun.

The earth is encircled by an envelope of ' gas ' or air known as the *atmosphere* (Fig. 65). It is estimated that the atmosphere is about 200 miles thick, although about 9/10 of the air is found within 12 miles and $\frac{1}{2}$ within about 3 miles of the earth's surface. We as human beings are, however, concerned only with the lower layers, while the upper layers serve no useful purpose.[1]

Air, besides having a variety of gases,[2] also contains particles of water-vapour (due to evaporation), dust and vegetable matter. Water-vapour is mostly confined to the dense lower layers—$\frac{3}{4}$ below 13,000 feet. The amount of water-vapour differs from place to place and time to time. Warm air can contain more moisture than cool air.[3] Humidity is the term used to signify the dampness of the air. ' *Absolute Humidity* ' means the actual amount of water-vapour present in the air at a certain place. When air has as much moisture as it can hold, it is said to be ' *Saturated.* ' The proportion of vapour present in the air as compared to the maximum is called ' *Relative Humidity.*'

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[1] The lower layers, *i.e.*, upto 6 miles of the earth's surface is called ' Trotosphere ' ; ' Strotosphere ' is the name given to the upper layers.

[2] Nitrogen 78·08 per cent, Oxygen 20·95 per cent, argon 0.93 per cent, carbon dioxide 0·03 per cent, Neon ·0018 per cent, Helium ·00058 per cent.

[3] *E.g.*, a cubic foot of air at 60°F. can hold about 6 grains of water.

Pressure.—Air has weight—one cubic foot weighs about 1¼ ounces. Hence the air situated near the surface of the earth, is compressed by the weight of the remainder of atmosphere resting on it. So great is the 'pressure' that at sea-level the average is about 15 pounds to every square inch. Pressure is measured by a barometer and expressed as a height. An increase in altitude marks a decrease in pressure. Pressure decreases at the rate of 1 inch after 900 feet of ascent. The decrease at greater altitudes, however, is not so marked.

In maps the distribution of pressure is shown by means of '*Isobars*,' *i.e.*, lines joining places of equal pressure. While drawing maps, however, the pressure is reduced to sea-level before isobars are drawn. This is done to maintain the uniformity of pressure distribution.

Pressure Belts—The chief importance of pressure is its control of winds. Wind is simply 'air in motion.' This horizontal air movement is meant to compensate pressure differences, *i.e.*, winds blow from regions of high pressure to regions of low pressure. A decrease in average pressure signifies ascending winds and also an increase in the absolute humidity of the air. It means that air is expanding (mostly due to heat) and getting lighter. On the other hand, an increase in average pressure usually means descending winds and the presence of dry air.

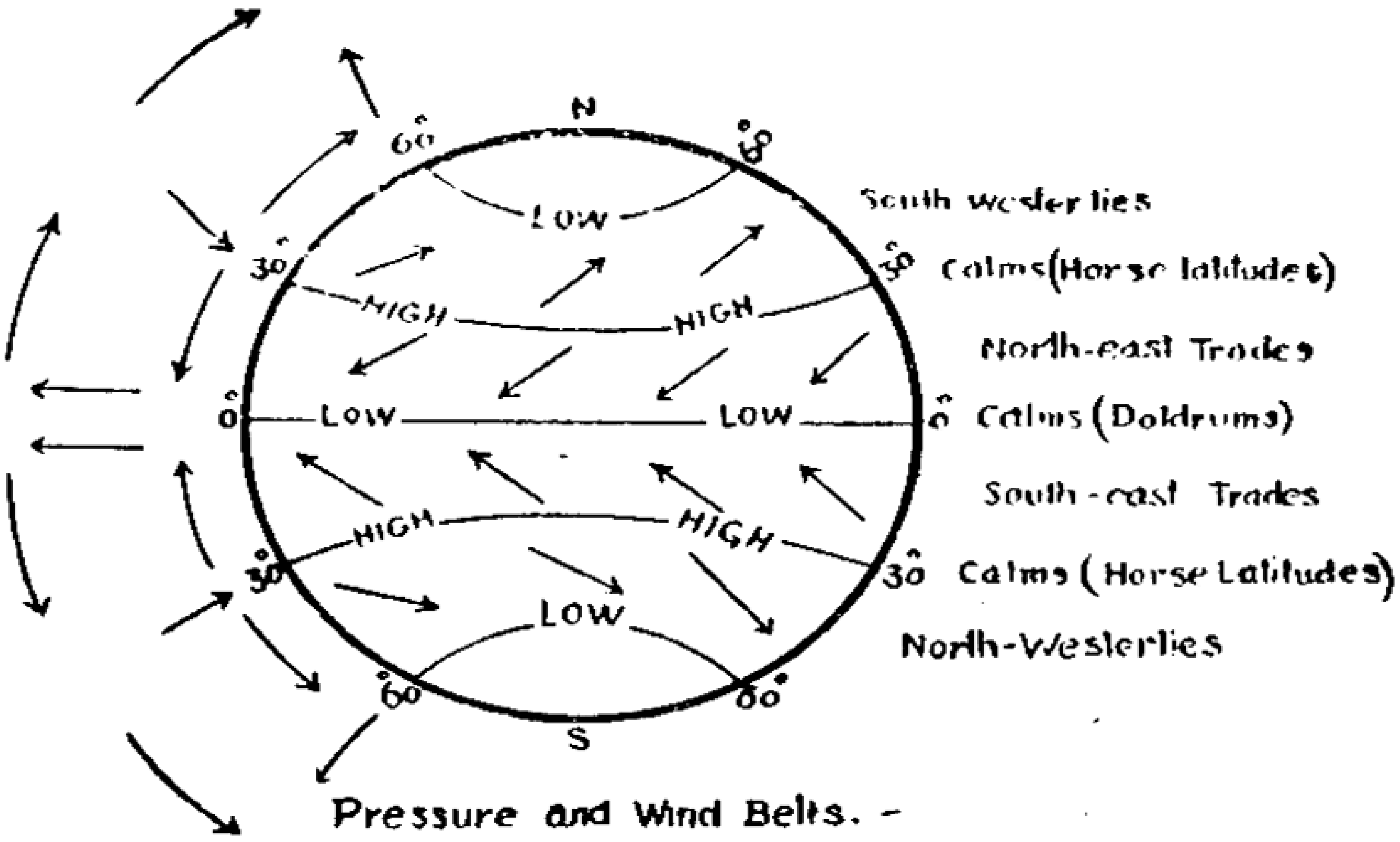

Fig 66. Pressure and Wind Belts

The hot belt near the equator where the most direct rays of the sun fall should be a low-pressure area. In the cold regions near the poles, the pressure should be high.

Figure No. 66 shows the pressure belts as they are situated. The low pressure belt is where it is expected *i.e.* near the equator. But you find the high pressure belts near 30°N and S and 35°N and S while in the northern regions (60° and near about) one finds low-pressure belts. Our knowledge about the pressure conditions at and around the poles is as yet scanty. It is, therefore, clear that temperature alone does not affect the distribution of pressure. There is something else also. That factor is the rotation of the earth. We have a low pressure belt at the equator because of the great heat. A low pressure belt is situated at 60 N and S because of the rotation. And as a consequence of these two, there is a marked high pressure belt about 30°N and S. (Horse latitudes).

Winds.—Winds, as a rule, blow from high pressure to low pressure. Now let us see how the pressure belts would influence the winds on the globe. Winds fall into 4 types, *i.e.* (1) Permanent or Planetary winds, (2) Seasonal or Periodic winds, (3) Aperiodic or Variable winds and (4) local winds.

(1) **Permanent winds.**—Under this major type we include (*a*) the Trade winds that blow from the sub-tropical (30 N and S) high pressure belts towards the equatorial calms and (*b*) the Anti-Trade winds that blow from the same regions towards the Northern low-pressure areas (60 N and S)—Fig. 66.

The above winds, however, do not blow straight from their origin to their destination. The rotation of the earth gradually deflects them to their right in the Northern hemisphere and to their left in the Southern hemisphere.

The Trades, therefore, become North-East in the Northern hemisphere and South-East in the Southern Hemisphere. They are accordingly referred to as the 'Easterlies.' The Anti-Trades become South-West in the Northern Hemisphere and North-West in the Southern Hemisphere and are often called the 'Westerlies.'

(2) **Seasonal winds.**—(Monsoons):—These are due to (*a*) the swing of the wind belts and (*b*) unequal heating of land and sea masses that causes land and sea breezes.

On account of (*a*) the inclination of the earth's axis, (*b*) earth's rotation, and (*c*) earth's revolution, the 'Thermal equator' or the region of the greatest heat comes to about 12 N and 8S during northern and southern summers respectively.[1]

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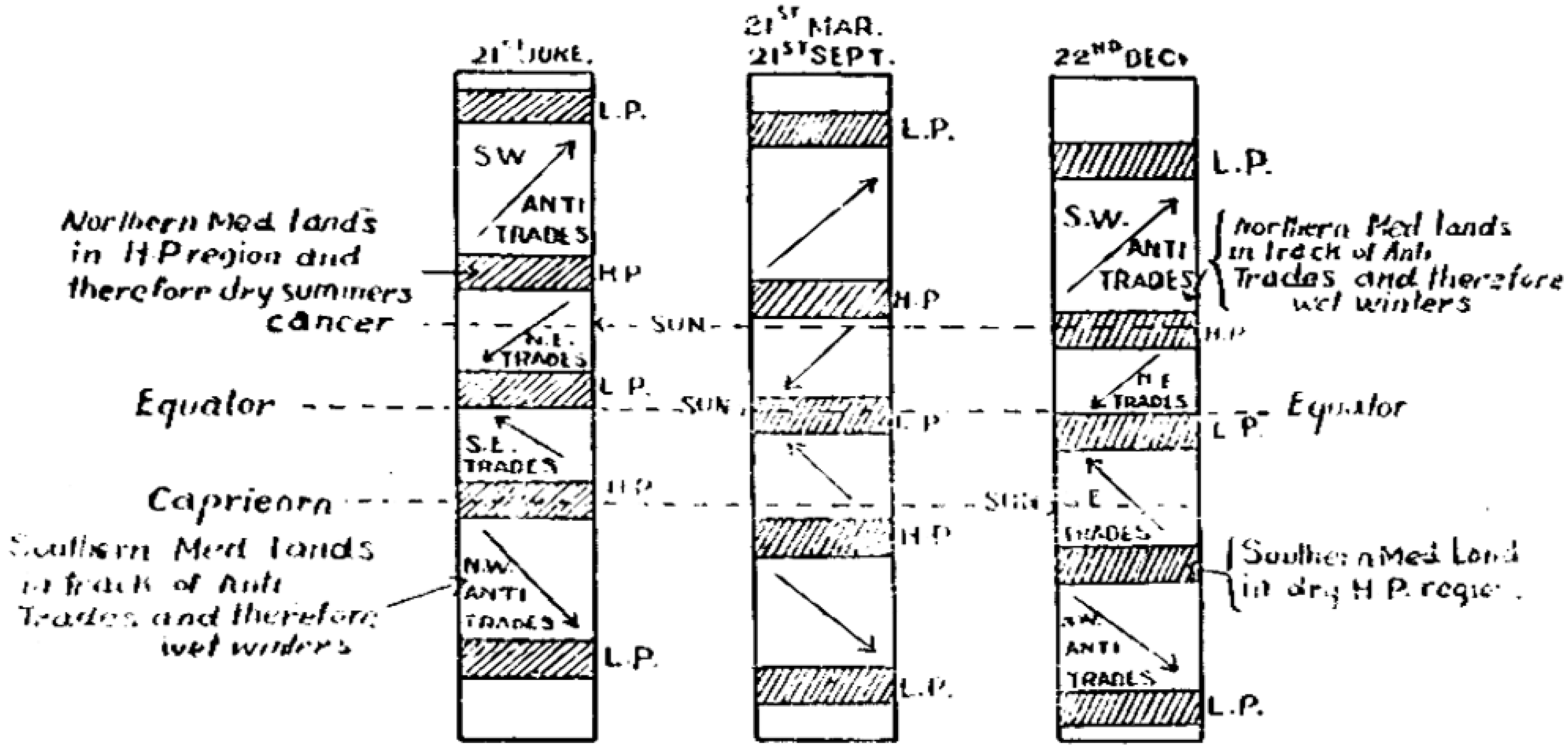
[1] The difference in its average positions in the two hemispheres is due to the presence of greater amount of land in the Northern Hemisphere and the slightly longer period for which the sun is there.

The pressure belts migrate with the above movement of the thermal equator and as a result of this, the wind belts also migrate, accordingly. (Fig. 67).

On account of this shifting of pressure belts, two changes occur in the wind belts.


21st JUNE.
21st MAR.
21st SEPT.
22nd DEC.
L.P.
H.P.
SUN
S.W. ANTI TRADES
N.E. TRADES
S.E. TRADES
N.W. ANTI TRADES
Northern Med. lands in H.P. region and therefore dry summers
cancer
Equator
Capricorn
Southern Med. lands in track of Anti Trades and therefore wet winters
Northern Med lands in track of Anti Trades and therefore wet winters
Southern Med. Land in dry H.P. region.

THE "SWING OF THE WIND SYSTEMS" AND ITS EFFECT ON MEDITERRANEAN LANDS.

Fig. 67. To Explain the swing of wind Belts. (After Thomas.)

(*a*) When the low pressure area is at 12°N or 8°S, the respective Trade winds have to cross the equator in order to reach it. As soon as the equator is crossed, deflection takes place and N. E. Trade winds become N.W. and S.E. Trade winds become S. W. (See the relevant figure). These seasonal winds are also sometimes referred to as the *Monsoons*.

(*b*) Between 30 N. and S. and 40. N. and S. a region is created where Trade winds blow in the Summer and anti-Trade winds in the Winter. This causes what we call the 'Mediterranean' and the 'China' types of climates—an account of which is given elsewhere in this book.

Land and sea breezes on a large scale also come under the same category. The marked example under this type are the monsoons of S. E. Asia and India which are caused by the winter High Pressure area and the Summer low Pressure area in central Asia.

3. **Variable winds.**—Under this category, we include *cyclones* and *anti-cyclones*.

In the westerly wind belts there are frequent and irregular changes of weather. These changes are caused by the succession of travelling cyclones and anti-cyclones.

Cyclones are low-pressure areas (depressions) while anticyclons are high-pressure areas (fig. 68). Both are shown on a map by a series of enclosed concentric isobars. In the cyclones pressure increases outward from the centre, while in the anticyclone, the pressure decreases outward from the centre.[1] They vary in size from thousands of square miles in area, to about 50 square miles or even less. Usually the anti-cyclones are larger by about one-fourth than the cyclones. They move in a general eastward direction with the west winds. Their average speed varies from about 20 miles an hour in summer to about 30 miles an hour in winter. It has not yet been recognized that both the cyclones and anti-cyclones have a vertical structure as well.

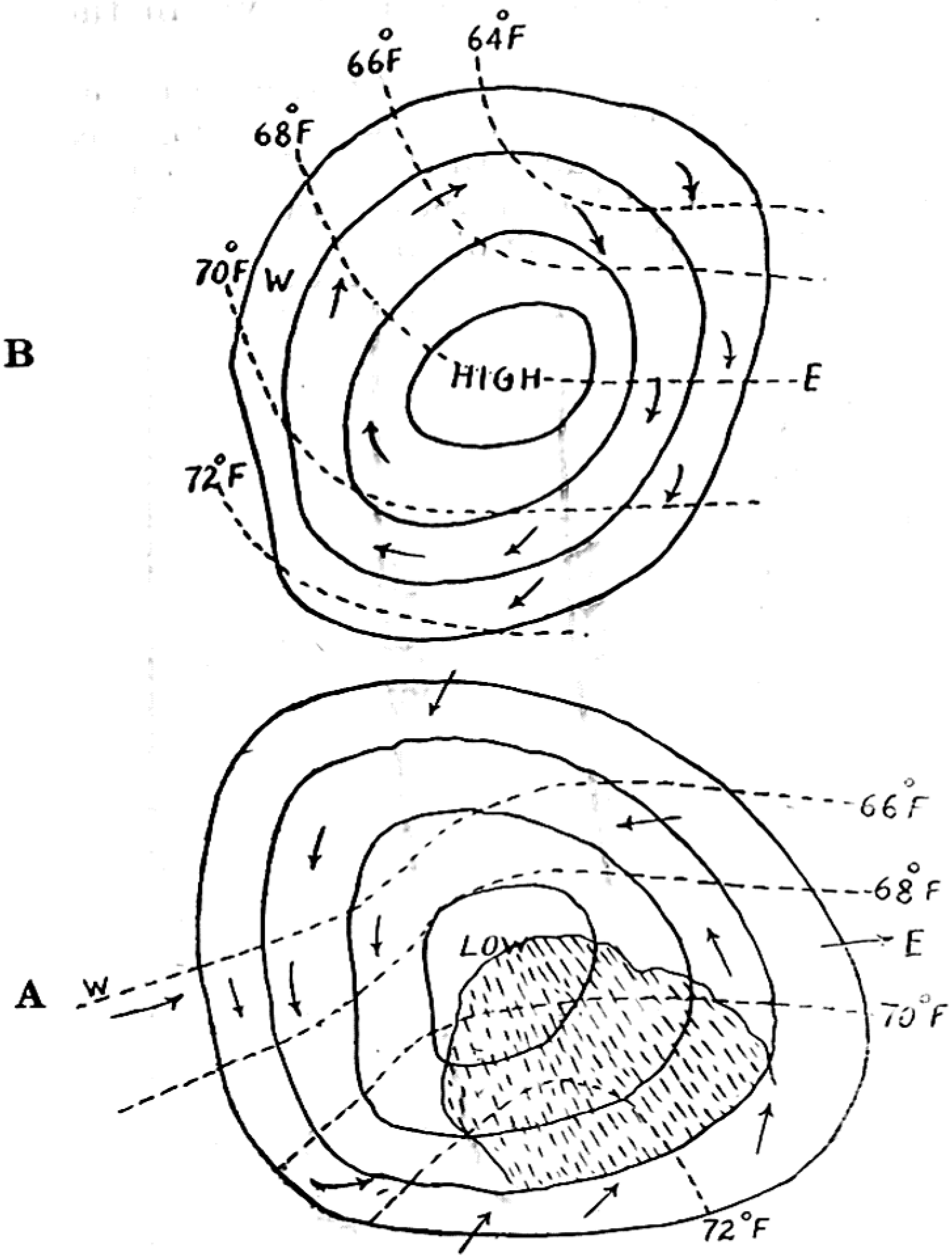


Fig. 68. A. Cyclone. B. Anti-Cyclone.

In a cyclone winds blow, as shown in the figure, inwards in an anti-clockwise direction.[1] When a cyclone approaches, the barometer falls, but the barometer rises on account of the warm South and South-West winds in the front of the system. The moisture-laden air of a cyclone rises and causes rainfall which is heavy in the centre of the depression.[1]

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[1] No definite pressure, in terms of barometeric readings, distinguishes a cyclone from an anti-cyclone.

[2] In the Southern hemisphere cyclonic winds blow in a clockwise direction in accordance with the Ferrel's law.

If the pressure gradients are sharp (in this case the isobars are closer together), the wind is usually strong and the resulting storms are harmful. In the West Indies, such cyclonic stroms are called 'Hurricanes'; in the West Pacific and China they are called 'Typhoons'.[2]

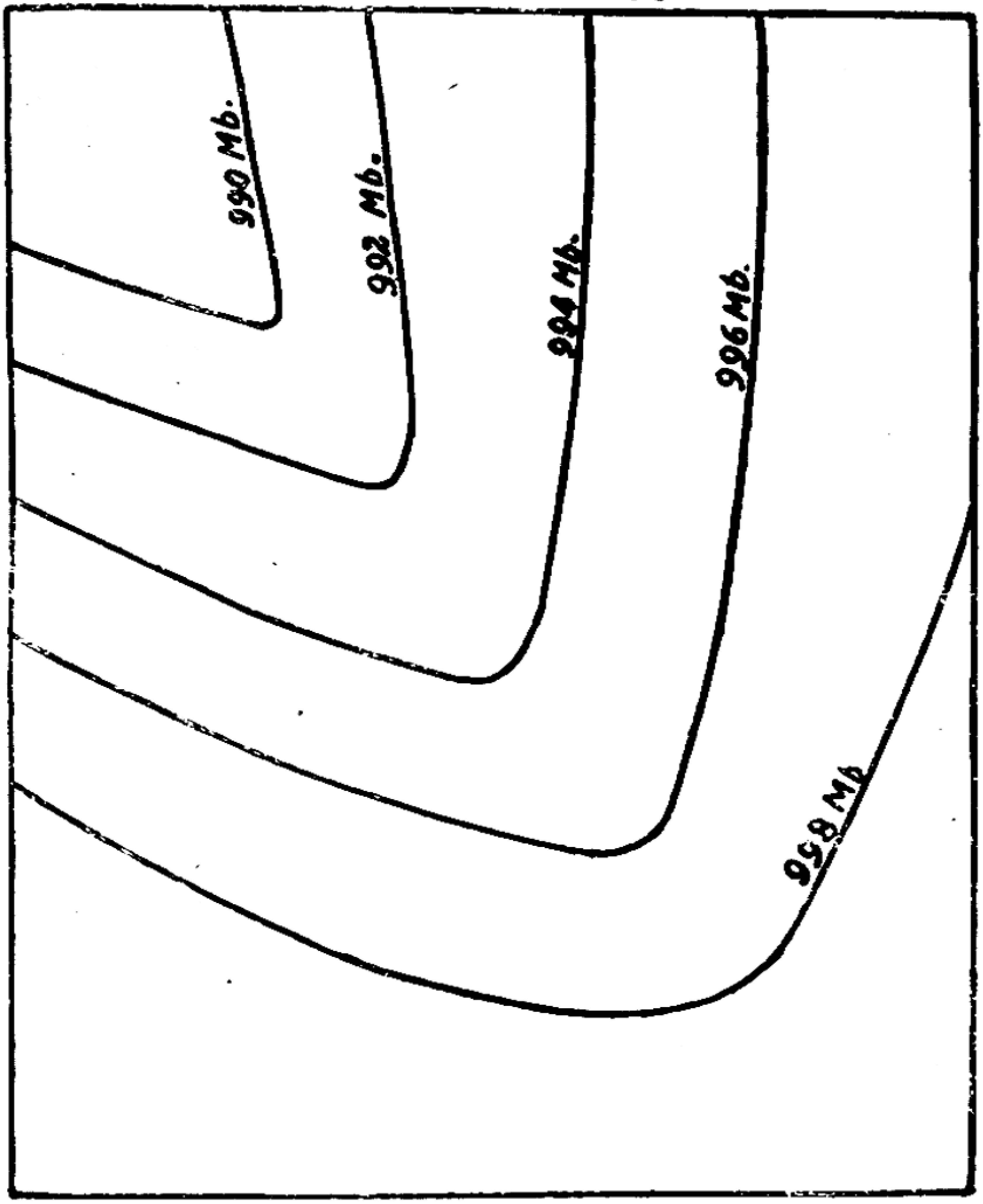

Fig. 69. A V-Shaped Depression

In an anti-cyclone, the winds are usually light and blow spirally outwards in a cloackwise direction. As the air is in a descending movement, it is warmer and tends to gather moisture rather than deposit it and so the anti-cyclonic weather is usually dry and bright. The fine weather associated with an anti-cyclone remains at a place for a longer period because an anti-cyclone tends to remain stationary, until displaced by a cyclone.

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[1] Small low-pressure areas, called *Secondaries*, occur on the edge of a big depression, moving round it in an anti-clockwise direction.

[2] Tornadoes of U.S.A. and the Simooms of Sahara are of similar nature.

V-shaped depressions.—They are usually associated with the warm front or cold rear of a cyclone (The isobars are v-shaped). If associated with the former, the weather will be wet followed by mild cloudy conditions ; if associated with the cold rear, as is most usual in temperate latitudes, the rain ends with a clearing shower, and brighter cooler weather ensues.

Wedge of high-pressure.—A wedge which projects between low depressions, is usually recognized as being one of the most consistently *fine* of all pressure types. At its worst, it can give showers only in its rear.

Col.—It occassionally happen that cyclones and anti-cyclones are separated from each other by a rather indeterminate belt of pressure. This *isobaric col* is a variable, and usually a transitory feature. Its winds are usually light and favourable to "radiation weather" in winter and to thunder-storms in summer.

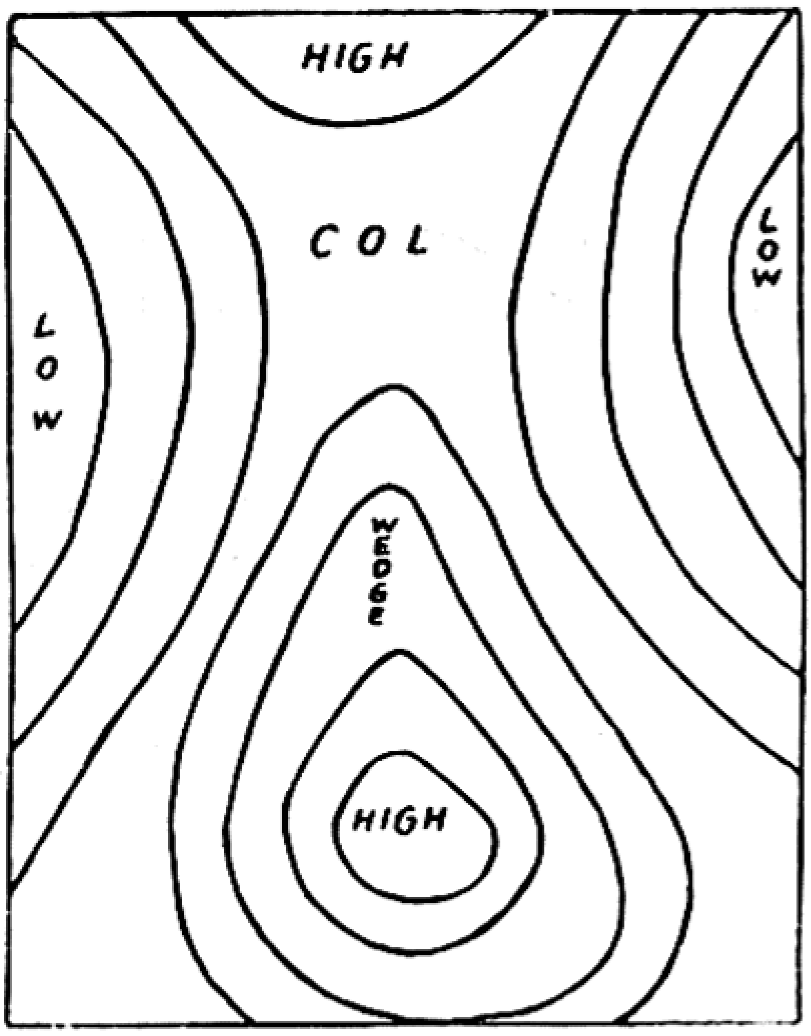


Fig. 70 Col. and Wedge.

(4) **Local winds.**—Under this title, we are going to consider winds that originate in some areas owing to some local causes and are only of local importance as they have a considerable effect on the climatic conditions of those particular localities.

(*a*) *Fohn* is a warm dry wind of the Alps and blows downwards chiefly in the valleys of the North. Tempratures rise quickly and the snow melts with great rapidity.

(*b*) *Chinook* is a similar hot dry wind, descending from the Rockies to the valleys and plains lying in the East. It turns the grass into hay, and in winter keeps the grazing grounds free of snow.

(*c*) ***Harmattan*** is a hot, dry and dust-laden wind that blows from the Sahara to the Sudan in October to February.

(*d*) ***Sricco*** is a hot, dry wind blowing from the Sahara to the Mediterranian. It is harmful for vegetation. In Egypt it is called by the name of " Khamsin."

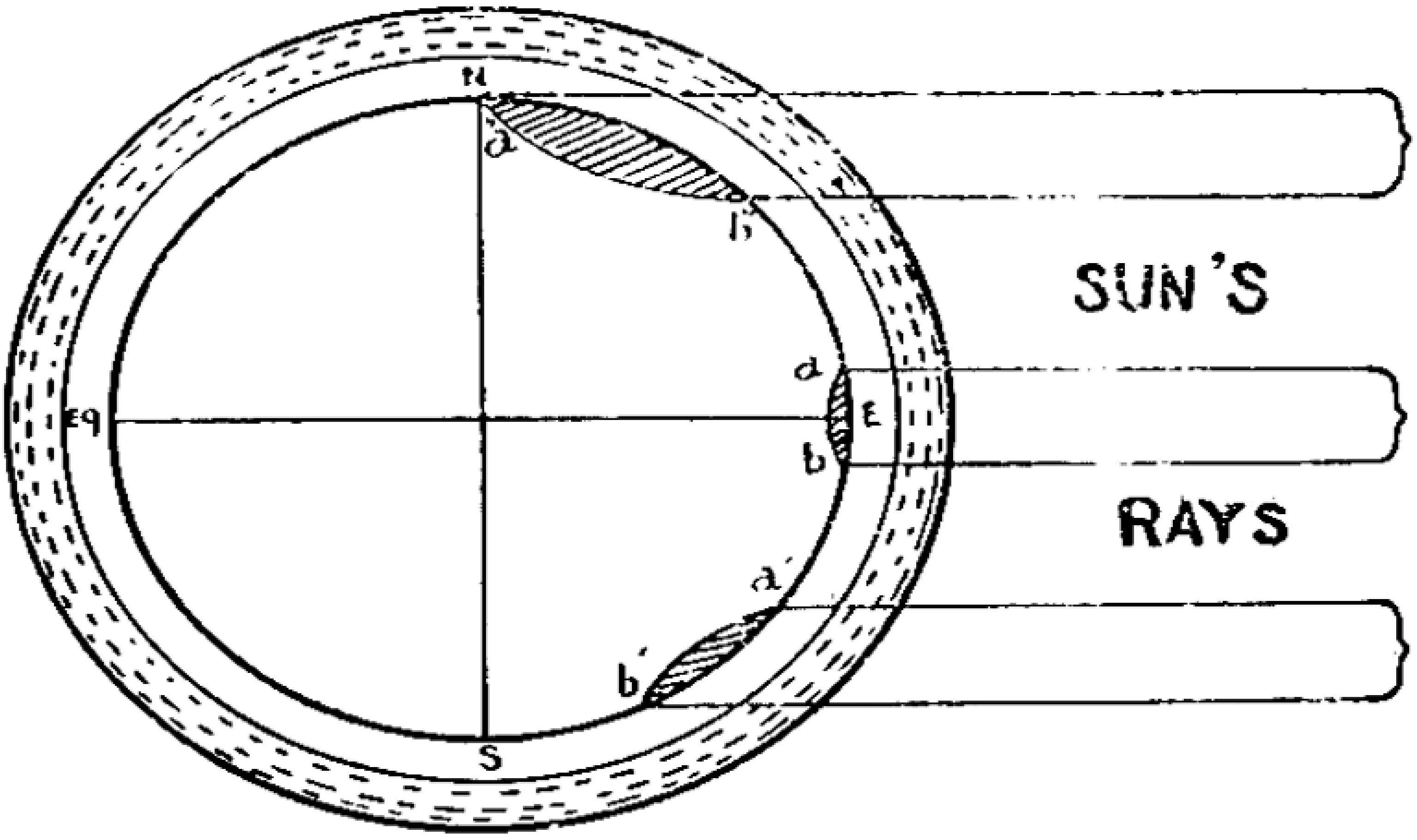
(*e*) ***Mistral and the Bora*** are cold North Winter winds of forceful intensity. The Mistral sweeps down the Rhone Valley and across the Mediterranean coast. The Bora blows across the Dalmatian coast.

SECTION II

CLIMATIC STUDIES

A. **Weather** is the condition of the atmosphere at a certain place at a particular time. When we say that ‘it is very hot, we are referring to weather conditions. The average weather conditions of a certain place determine its *climate*

If we wish to find out the climate of a place, first of all we should take the temperature of the air at different seasons of the year; secondly we should know something about the prevailing winds and about the pressure conditions; and lastly we must measure the amount of annual rainfall. In order to find out the correct climate of a place we must note these things for a number of years and then find out the averages.



Direct and Slanting Rays.

Fig. 71. Temperature decreases northwards and Southwards from the equator. Areas ab, $a'b'$ and $a''b''$ vary in size but are heated by the same bulk of sun's rays.

Temperature.—We get heat and light from the sun and the amount of heat received at different places is not the same. The reasons for this difference in the amount of heat received (or temperature) are as follows :—

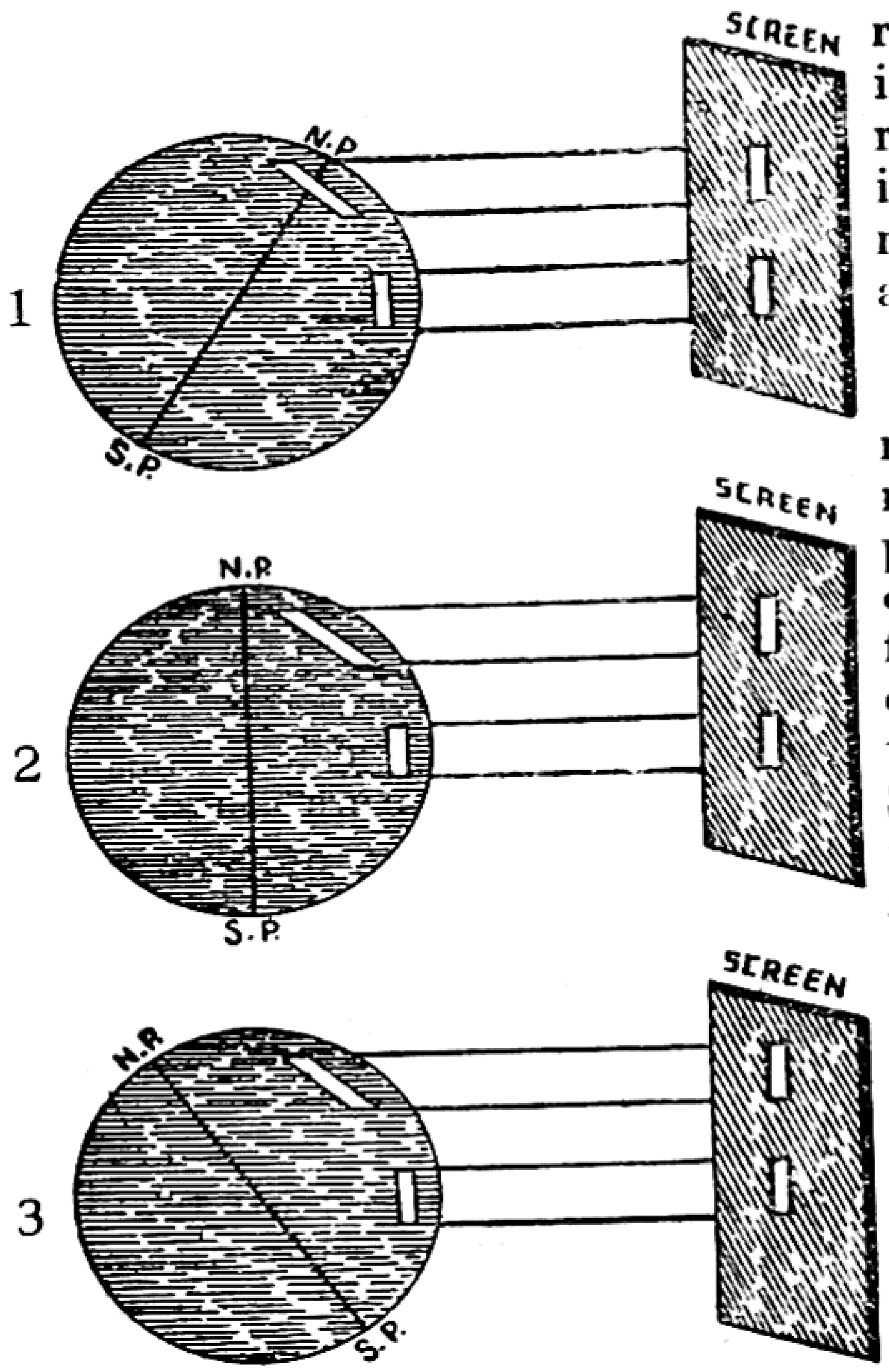


Fig. 72. Effect of the distance from the equator and of the inclination of the axis of the earth. Though the apertures in the screen through which heat is coming are the same everywhere, the areas marked vary in size.

The figure shows three positions of the earth. (1) Summer solstice, (2) equinoxes and (3) Winter solstice (after Huntington and Cushing).

(*a*) On account of the roundity of the earth, the rays of the sun have to pass through a greater bulk of atmosphere as we go farther away from the equator *i.e.*, as we proceed towards the North and the South, temperature (which is a term used for the amount of heat received) gets and less and less. This thing has been very clearly shown in figures (Nos. 65 and 71).

(*b*) As shown in figures 71 and 72 the bulk of the rays of the sun heating a certain area is greatest near the equator and it gets smaller as we go further away from it. This factor is also equally responsible for diminishing temperatures towards the North and the South.

(*c*) The sun is overhead only at the Equator and in the Tropics because of the tilting of the earth's axis. This also contributes to the fact that temperature decreases North and South of the Equator.

According to the above three facts we can elicit a general rule : "As the latitude increases, temperature decreases." Figure No. 73 show the various temperature zones :—

1. The *Torrid zone* extends 23½° N and S. There

the temperature is uniformly high all the year round. Sun is overhead once at the two Tropics only (Cancer and Capricorn) and twice everywhere else during the course of the year.

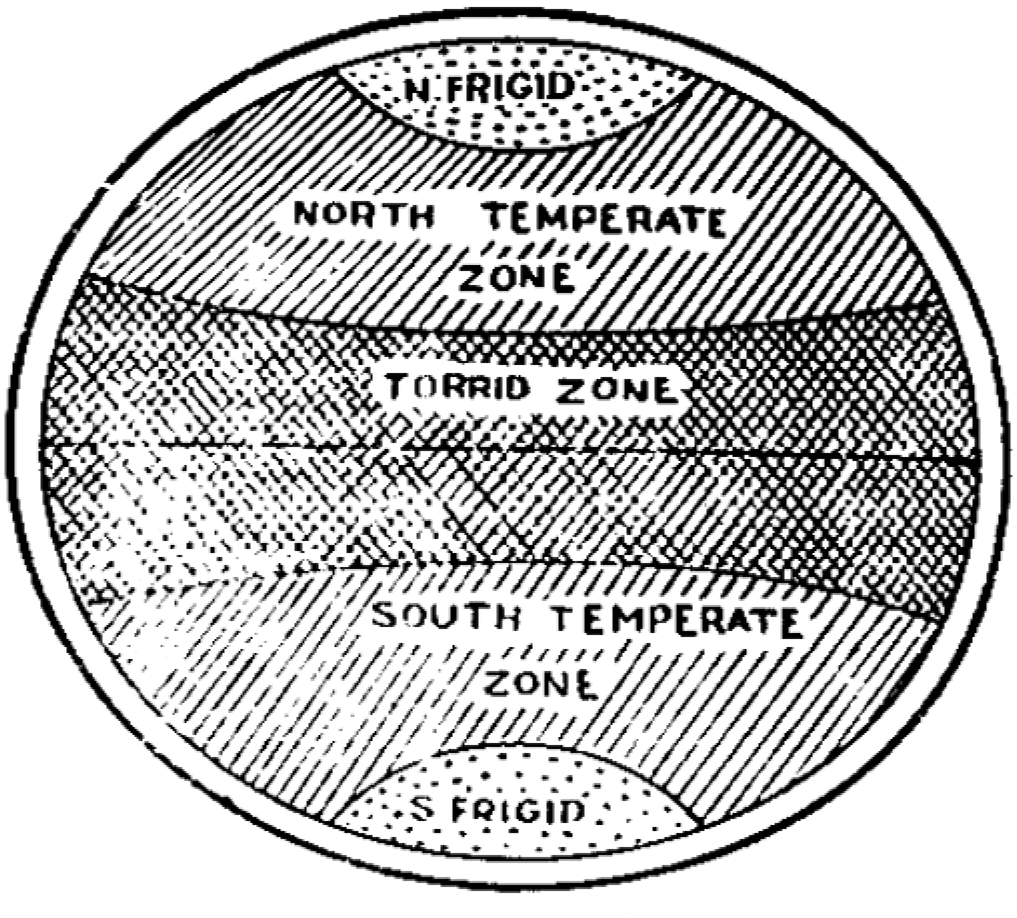


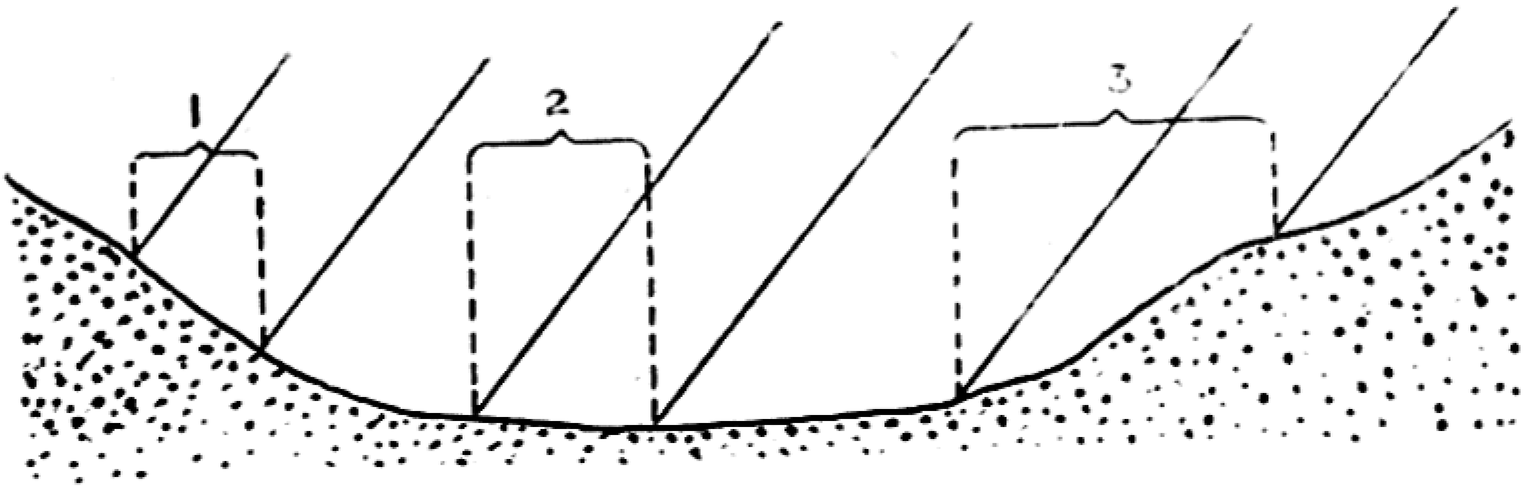
Fig. 73. The various temperature zones.

2. The North and South *Temperate zones* are situated between 23½° N and S and 66½° N and S. There is a general decrease in temperatures and it continues polewards. They may be further divided into (*a*) warm temperate zones and (*b*) cool temperate zones ; the former comprising of the equatorial halves and the latter of the polar halves.

3. Between 66½° N and S (or the Arctic and the Antarctic circles) and the poles, are situated the cold *Frigid zones.*

It has been established that the rarified air found in higher regions absorbs less heat than the denser air found in lower regions. This results in the decreases of temperature as we ascend. Meteorologists whose business it is to study the climate, have calculated the average rate of this decrease. After every three hundred feet of ascent the decrease in temperature is 1°F. *Inversion of temperature* is sometimes experienced in mountain regions. It very often happens that the temperature is lower in the valleys than at higher altitudes. In bright and calm Winter days the cool heavy air blows downwards and decreases the temperature of the valleys. The effect is increased in the night. It is due to this strange phenomenon that villages are usually situated on the Southern mountain slopes (in the nothern Hemisphere) and not in the actual valley floors. Locally the rate of decrease varies with the land-form, with the season and with the time of the day. In the Eastern Alps the average decrease is more rapid in summer (1°F in 290 feet) than in winter (1°F in 360 feet).

The slope of the land also affects the distribution of the rays of heat. On flat land and gentle slopes, the area heated by a bulk of rays is much less than on steeper slops. This has been shown in figure 74.



EFFECT OF SLOPE ON CLIMATE.

Fig. 74.

Water heats and cools slower than land, *i.e.*, the waters of the oceans 'are not subject to very rapid and great changes in temperature'. Consequently in winter the winds from the oceans are warmer than the winds from the land and in summer they are relatively cooler. These oceanic winds lower the temperatures of the coastal regions in summer and make the winters milder. But this moderating influence of the sea decreases as we go into the interior. We can therefore deduce another geographical law: "Places situated on the sea coasts have mild winters and cool summers," *i.e.*, the difference between their winter and summer temperatures is not big. On the other hand, places situated inside the continent have hot summers and cool winters, *i.e.*, the difference between their winter and summer temperatures is marked. Now, therefore, you should be able to tell by a study of the monthly temperatures of a place whether that place is situated on the coasts or in the interior of the country.

Some places are warmed or cooled by neighbouring ocean currents. By way of example we may cite the case of North-West Europe (specially Norway) which is warmed by the North Atlantic Drift, an extension of the Gulf Stream.

Sometimes winds are also responsible for the raising or the lowering of the temperatures of certain places. If the winds are coming from cooler regions they are cool themselves and lower the temperatures of places they visit. Similarly if they are coming from hot regions they increase the temperatures of the places they visit.

Above have been enumerated some of the factors that we have to take into consideration while studying the temperature of a certain place. If our places are very far away from the Equator they should be cold. If they are situated on a high mountain they should be cool even if they are near the Equator. Places on the sea coasts have neither very hot summers nor very cold winters; while places in the interior of the continents havea big range of annual temperature.

Temperature studies :—The given maps (**Fig. 75 and 76**) show the summer and winter distribution of temperature over the earth. Isotherms have been used for this purpose. An sotherm is a line joining places of equal mean temperatures

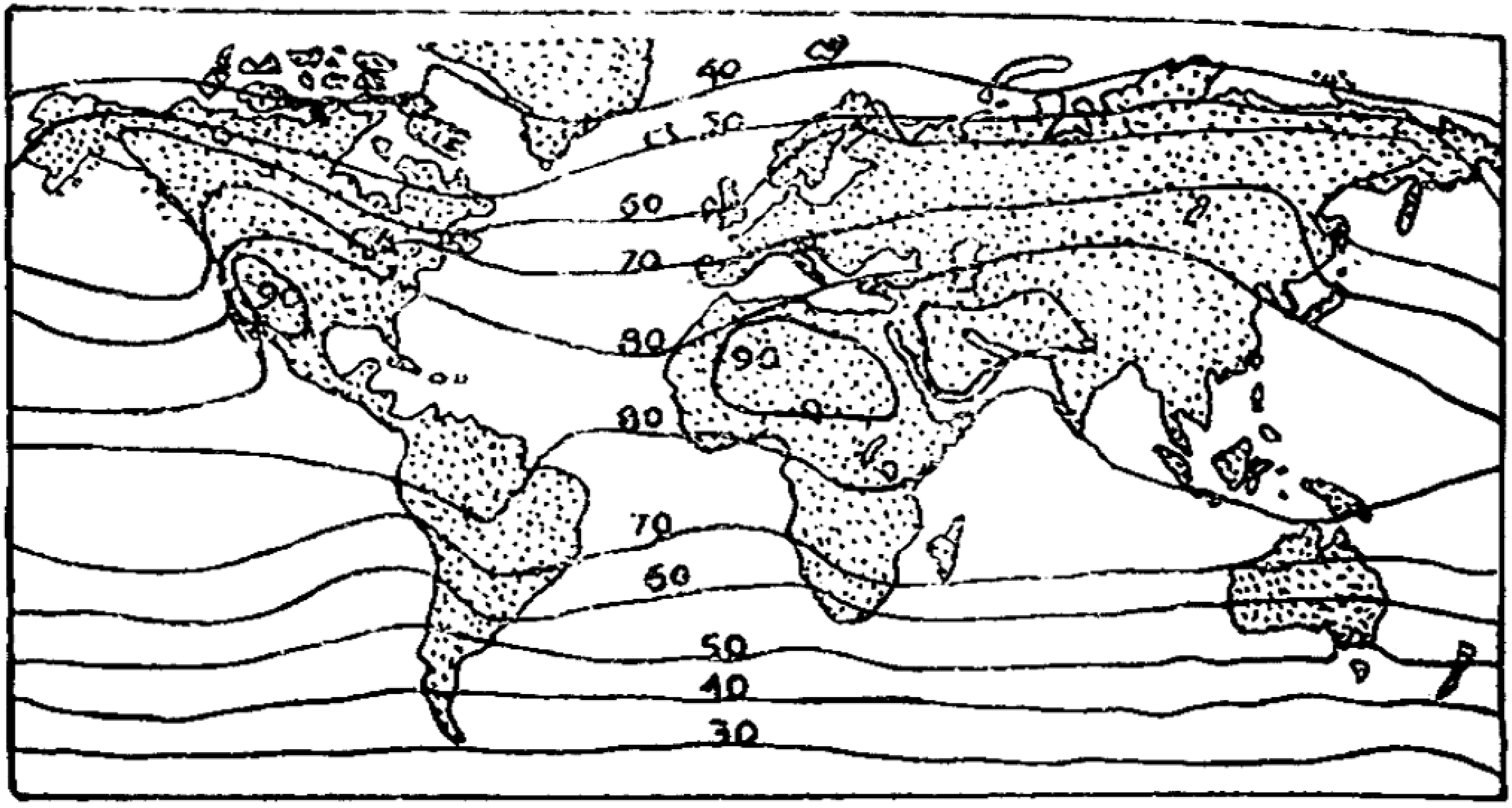


Fig. 75. Summer (July) isotherms. Temperature in degrees Farenheit.

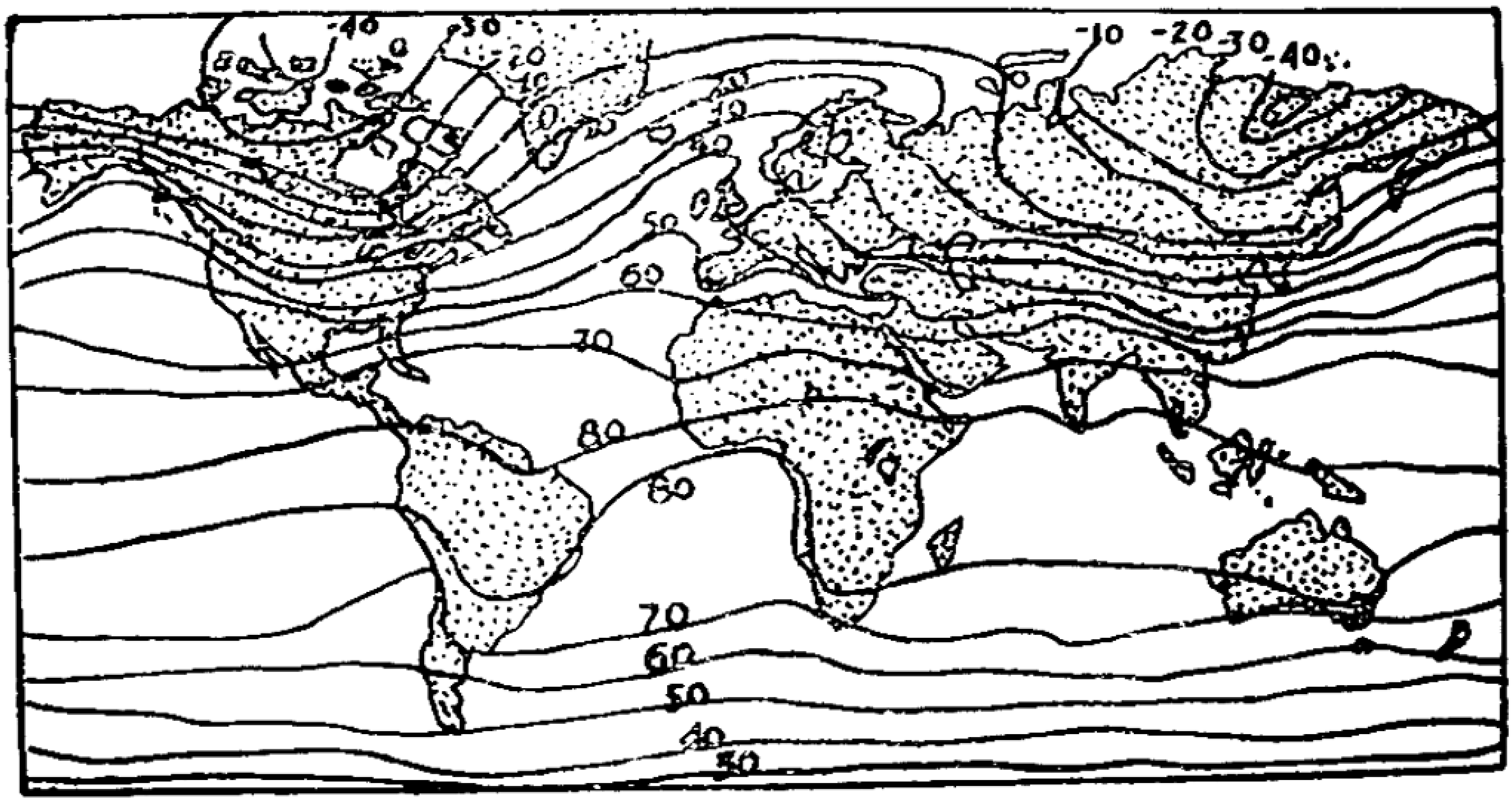


Fig. 76. Winter (January) isotherms (Temperature in degrees F.)

on a map. The temperature is always reduced to sea-level for this purpose. A study of the maps reveals very distinct studies, *e.g.* (*a*) Temperature belts, (*b*) Shifting temperature belts and (*c*) oceanic temperatures.

(*a*) At and near the equator, the temperature is always high and varies but little, being greatest during the summer.

Places at and near the Tropics show the greatest variation of temperature, but the temperature never goes down appreciably.

In middle latitudes, summers are comparatively warmer and winters are decidedly cool.

In high latitudes, summers may show some increase in temperature, but the greater part of the year is very cool, winters being very cold.

In the Polar latitudes, for the greater part of the year, temperature is below freezing point; only during mid-summers, it may rise to a few degrees.

(*b*) *Shifting Temperature Belts* :—It is interesting to consider the shifting of the temperature belts over the globe consequent to the shifting of the belt of the greatest insolation. At the equinox this belt is at the equator; during northern Summer, it comes about 23½ N while during Southern Summer, it goes South to a corresponding latitude. The heat, however, lags behinds the insolation belts more specially in the oceans. There this is so marked that there is no relationship between the ocean temperatures and the seasons and consequently the isotherms have to take big curves. Oceanic temperatures are lower for their latitude during summer and are higher for their latitudes during winter. The monsoon breezes also affect the coastal areas accordingly.

(*c*) *Occanic temperatures* :—Consequent to what has been said in (*b*), the temperature conditions in oceans and ocean-margins in the five belts dealt within (*a*) are as follows :—

(1) In the equatorial regions the slight variations of temperatures are reduced practically to zero.

(2) In the tropical regions the excessive heat near the solstices is very much moderated.

(3) In the warm temperate belts, winters become milder and the summers are moderated.

(4) In cool temperate regions, the differences are most marked.

(5) As the sea is mostly frozen, it has little or no effect on temperature.

Rainfall and Winds—Rainfall is a very important factor in a climatic study. Before we come to a detailed study of rainfall, it is essential that we should know something about '*Humidity*'.

Humidity as mentioned before, is the term used to express the dampness of the atmosphere. When the air contains as much vapour as it can hold, it is said to be 'saturated'. The proportion of water vapour in the air, compared with the maximum it can hold at the same temperature is called 'Relative Humidity'. Warm air can contain more water vapour than cool air.

Rain is caused by 'condensation' *i. e.* cooling of the air. When clouds are so full of water vapour that they are able to contain no more, they let some fall as rain. Winds cause rains in many ways and due to various causes :—

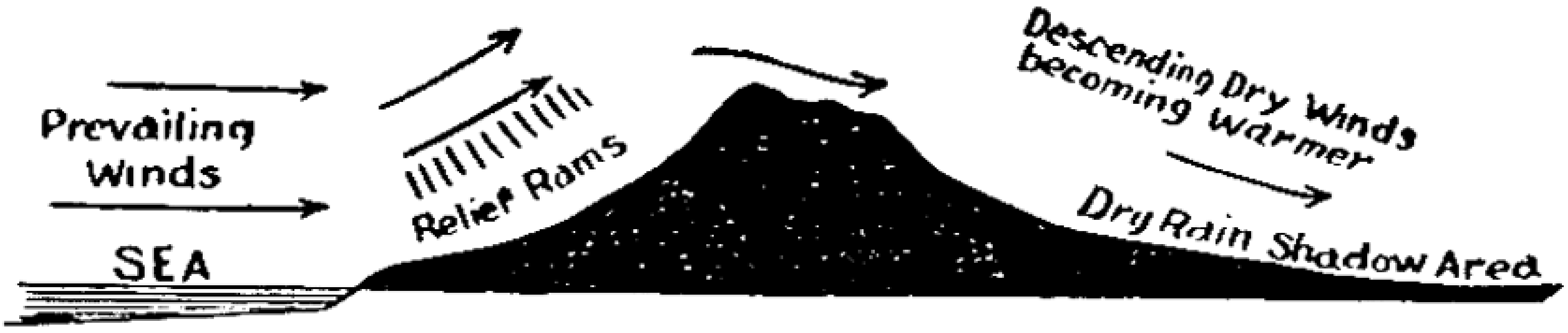
(1) When they blow from warmer to cooler latitudes.

(2) When winds rise either because of a mountain barrier or because of heating and expanding.

(3) Rains accompany cyclones.

The various types of rainfall are named after the above.

(*a*) *Relief Rains*—As the name signifies, such rains are caused by the relief of land. These are also known as 'Mountain Rains'. Nearly 80 p. c. of the rainfall in this world is due to the position of relief features. Wind blowing over rising land is bound to rise, *i. e.*, if it rises sufficiently, it cools and condensation takes place and rain falls. The average rate of cooling is 0·6°F for every 300 feet of ascent. The rate of cooling is, however, not uniform and upper slopes get less rainfall than the lower slopes. Again the rainfall is heavier on steeper slopes, because here the condensation will be spread over smaller areas.



Rain Shadow area

Fig. 77.—How Relief Rains are caused.

(*Note*—Read 'Relief Rains' for Relief Rams).

However, on the other side, which is called the 'leeward side', the winds descend and are naturally warmed by compression and their saturation capacity increases. Thus this leeward side receives little or no rainfall. A rain-shadow area is created there. Study the given figure explaining the idea of relief rains.

(*b*) *Convectional Rainfall.*—In the equitorial regions, *i. e.*, up to about 5°N and S, the conditions are favourable for heavy rainfall. There is present a low–pressure area with an upward drift ; owing to high temperature, evaporation is immense and the rising air is full of water-vapour. The cooling of this rising air gives heavy rainfall to these regions. As convection plays an important part in the production of rainfall in these regions, the rainfall here is called, '*Convectional Rainfall*'.

(*c*) *Cyclonic Rainfall*—The centres of cyclones have low pressures and are naturally associated with rising air currents. Cyclones bring cloudy weather and rain. It is the 'front' and the southern portions of the cyclones in the northern hemisphere that get rains, while in the southern hemisphere, the front and the northern portion of the cyclones are wet.

Rainfall associated with cyclones is called '*cyclonic rainfall*'.

Rainfall studies :—The map given on page 94 shows the annual world distribution of rainfall. A study of the same shows a vast range of variations both in the amount and the period of rainfall.

1. There is a belt of very heavy and perennial rainfall in the hot equatorial region.

2. In the Trade wind and the high pressure belts (Horse latitudes) rainfall is scanty more specially in the western areas and the continental interiors ; and large deserts like the Sahara are found there. On the eastern coasts that face the Trades, rainfall is heavy, *e. g.*, in Eastern Brazil and in Central America. In the regions of the seasonal moonsoons (like India and South-eastern Asia) the annual rainfall (more in summer) is normally sufficient for crops.

3. In the anti-Trade wind belts, the Western margins facing the westerly winds get heavy showers and there is a general decrease towards the east. The deserts (*e. g.*, Patagonia) are situated in the eastern regions.

4. Places that are surrounded on all sides or on the windward sides by mountains, are also dry and contain

vegetation corresponding to the degree of dryness. Examples of such shut-up regions are found in Central Asia, Rocky Mountain States and in the Great plains of U. S. A.

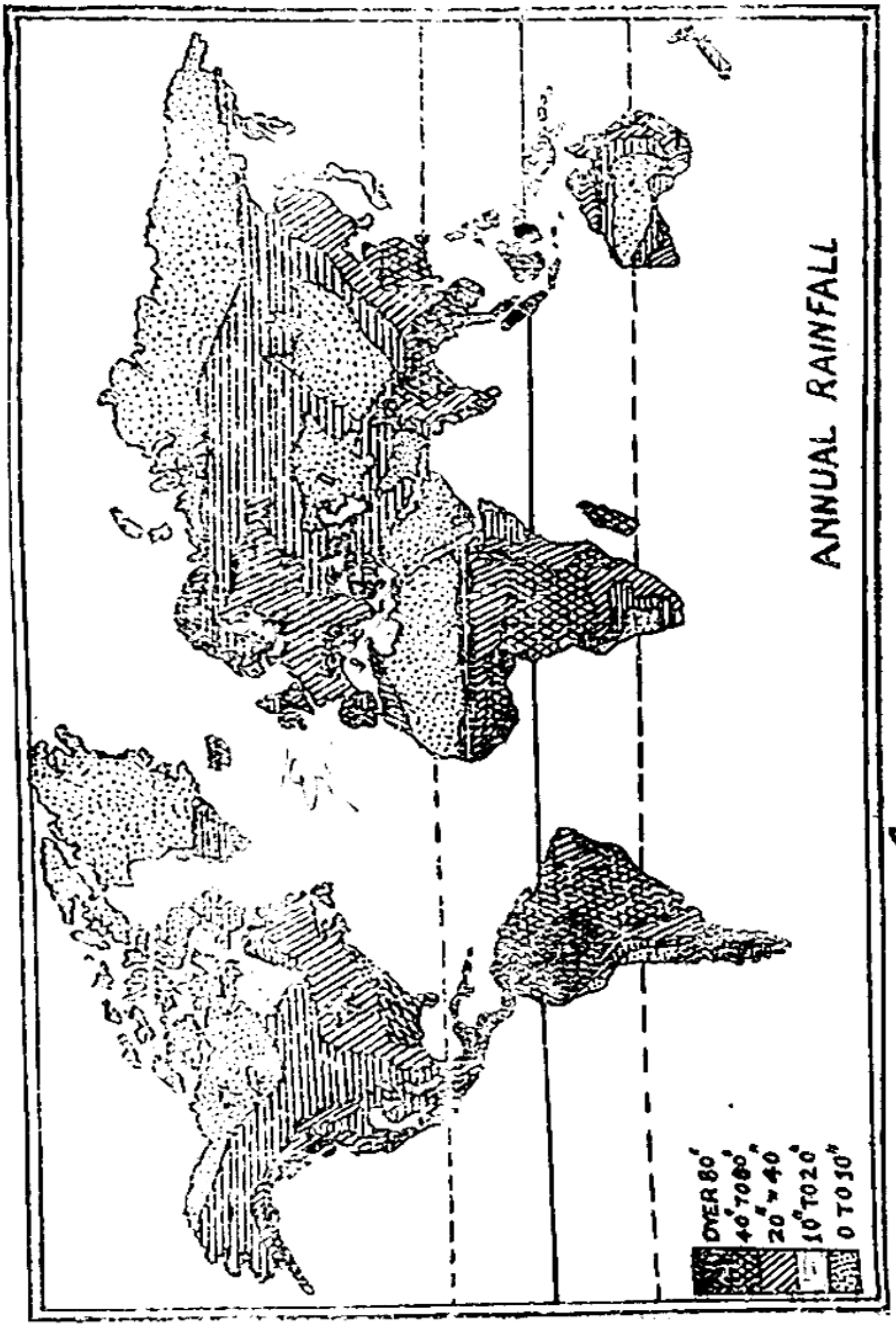


Fig 78.

5. Nearer the poles, evaporation is practically absent and humidity is very low. Rainfall is, therefore, very light and falls mostly in the shape of snow.

6. The amount of rainfall received by different places vary very appreciably. On one hand there are places like Cherrapunji in Assam Hills that get an average of over 450″ per year, while on the other hand places like Atacoma desert in South America get less then 1 inch in ten years.

7. Whether the rainfall comes in a heavy downpour or in gentle but uniformly distributed showers is also a question that deserves attention. Heavy downpour is not advantageous for agriculture as it leads to a considerable runoff and extensive soil erosion. Bombay's 72 inches come in an average of 75 days, while London gets its 24″ in 161 days. It is easy to know which is easier to do 'digested'. The heaviest daily rainfall ever recorded was 46″ in Bogino (Phillipine Islands)—July 1911. In India Cherrapunji once got 40″ and Nagina got 33″ in one day.

Major Forms of Precipitation

(*a*) *Clouds, mist and fog.*—Air, besides water vapour, also contains dust particles round which water condenses. When the condensation takes place close to the earth surface, *fog or mist* is formed. On the other hand, when similar condensation takes place at some height from the earth surface, *clouds* are formed. Land fogs occur most frequently in autumn and winter specially on calm nights. Fog is also caused by the meeting of slow-moving waves of air at different temperatures. Fogs are common over cold ocean currents and also at places (*e.g.*, near New Foundland), where cold currents meet warm currents.

Clouds are different from fog in their modes of formation and their characteristic shapes. Consequent to their characteristics, the more important types of clouds are (1) *Cirrus*: These are those delicate, fibrous, feathery wisps of whitish clouds that float high in the sky on a clear day. These are due to low temperatures which bring about condensation in the form of ice crystals; (2) *Cumulus*: These are the massive clouds of a cauliflower shape and are caused by currents of rising air. These are typical of the sky-cover of hot humid areas and of temperate zones in summer. The bases of such clouds lie usually at about a mile above the surface of the earth, but the fogs may protrude for several miles above their bases; (3) Frequently the lower layers of the cumulus clouds become dark and are usually associated with rain or snow. This cloud formation and also any rain cloud is called *Nimbus*; and (4) *Stratus*: There are uniform layers of clouds with no distinguishable cloud that are so common on 'dull grey days'. They are found on all heights above the earth surface right down from tree tops to five or even more miles above the earth.

Dew and Frost.—Dew is the result of condensed water vapour on cold ground or other objects during the night. The degree of temperature at which such condensation occurs is known as *Dew Point.* When this phenomenon takes place below freezing point, *frost* is the result.

Snow.—When water vapour condenses in the upper layers below the freezing point, the tiny particles of ice unite to form flakes that fall to the earth as snow (just like rain) provided the temperature of the lower layers of atmosphere is above 32°F. Commonly speaking 1″ of rain is equal to 10 to 12 inches of new fallen snow.

Hail.—Hail is a very unusual form of precipitation. It is frozen rain that has been carried upwards a number of times by rising air currents. This ascending process is continued till the frozen drops are large and heavy enough to overcome the resistence of the upward currents. Sometimes when the upward movement is very strong, the hail stones get very big and heavy—being about 4″ in diameter. Such destructive hail-storms are frequent on the South African Plateau during summer.

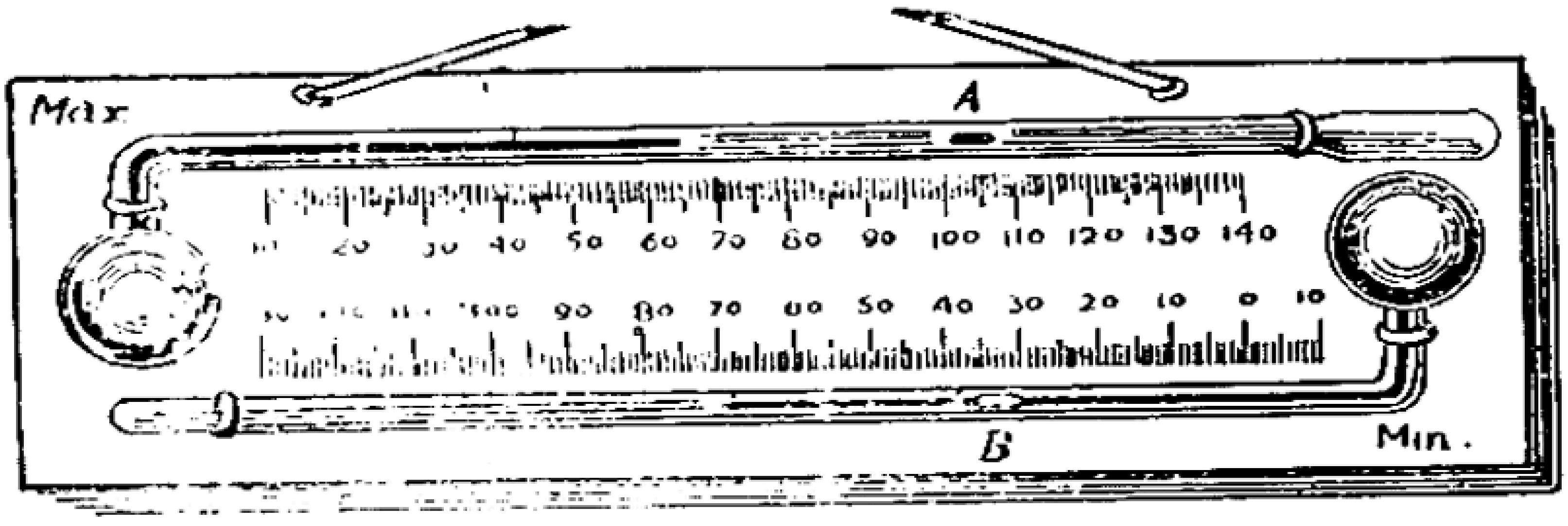
Recording Weather

How to record temperature, pressure, and rainfall?

In this section you will learn the use of some of the more important instruments for measuring temperature, pressure and rainfall.

The most important instruments used for measuring temperature are the following:—

(1) A *maximum and minimum thermometer* for registering the maximum and minimum temperatures during a fixed period.



MAXIMUM AND MINIMUM THERMOMETERS.

Fig. 79.

(2) An ordinary thermometer preferably with Fahrenheit readings.

(3) A *wet and dry bulb* thermometer which is used to find the amount of moisture in the air.

The liquid used in thermometers is mercury. When temperature rises mercury expands, and goes up in the tube, Generally we take daily averages of temperature and also monthly and seasonal averages. It is presumed you know how we take averages. To find out the *annual range of temperature* we substract the annual minimum from the annual maximum. To find out the *diurnal range* of temperature we substract the daily minimum from the daily maximum. In general climatic maps the average temperature for the month of January is taken to represent winter conditions and the average July temperature is taken to represent summer temperature. The mean temperature for the day can be had by adding the maximum and the minimum and dividing the product by 2.

For measuring pressure, a barometer is used. The figure 79 shows a simple barometer. The liquid used is mercury. We measure air-pressure by the number of inches of mercury, the barometer will support. For outdoor measurements an Aneroid barometer is used. Falling heights of the column of mercury indicate rain and unsettled weather, while a rising tendency indicates fine and settled weather.

In weather reports, barometer readings are given both in inches and Millibars (Mb). A Millibar is $\frac{1}{1000}$th of a ' bar ', which is a pressure corresponding to the height 29·5 inches in the Mercury Barometer. One Millibar is, therefore, equal to $\frac{29\cdot5}{1,000}$ inches or about $\frac{1}{34}$ of an inch.

A rain gauge is used for pouring the rain water collected during the day into the graduated glass. The readings of the glass are so adjusted that the depth of rain that has taken place is read off directly in inches and hundredths of an inch.

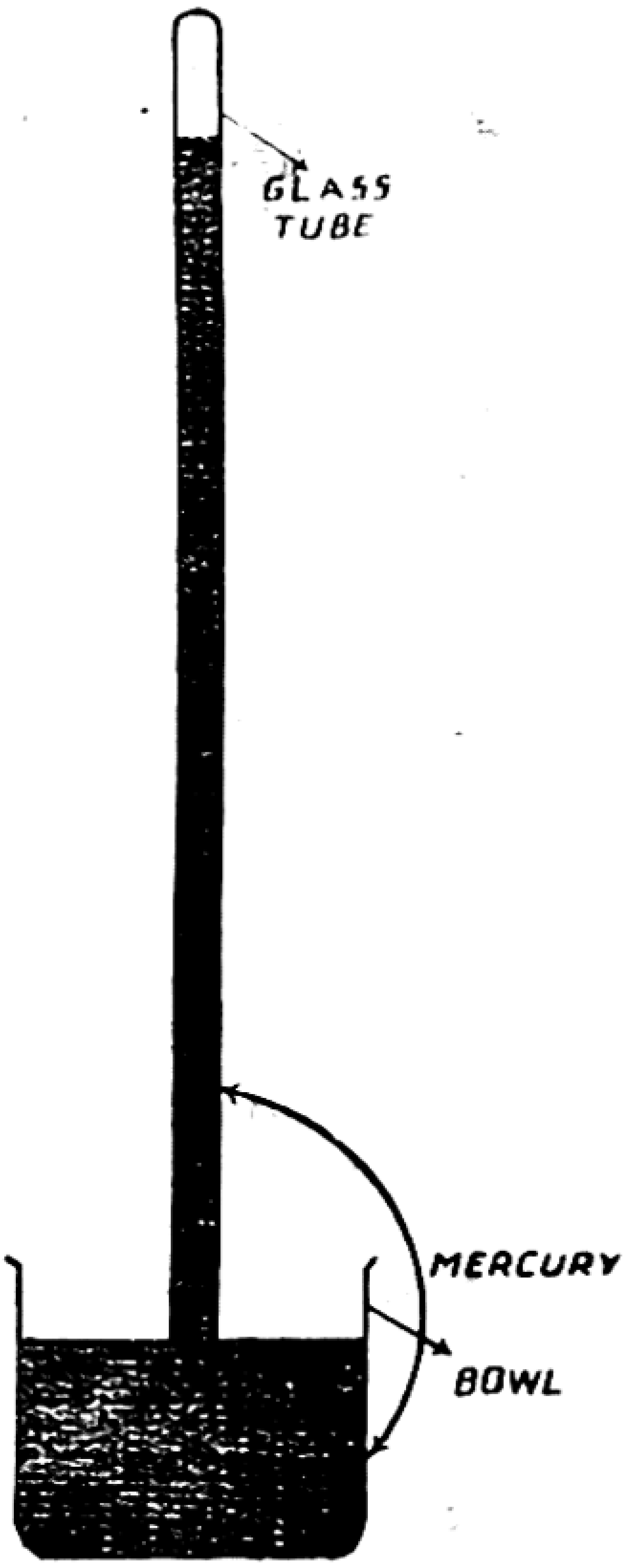


Fig. 79.—A simple Barometer.

In the case of rainfall the monthly rainfalls are had by adding daily rainfalls and the yearly rainfall is obtained by adding the monthly rainfalls. Yearly averages are obtained by adding the annual rainfalls of many years and then dividing the sum by the number of years. The departure from the average is called the *variability of rainfall.* It is either minus or plus and is usually represented as percentage.

Below is given how the daily weather records are kept. Readings are taken usually after every 24 hours (8 a.m.)

Daily readings for a certain town for a week.

Date		*Pressure*		*Temperature*			*Rainfall*	
1st	Nov.	29·99	inch	Max.	Min.	Mean.	0	
2nd	,,	29·95	,,	48	30	39	.01	inches
3rd	,,	29·94	,,	56	48	52	·06	,,
4th	,,	29·95	,,	59	51	55	·03	,,
5th	,,	29·89	,,	59	50	54·5	·07	,,
6th	,,	30·21	,,	56	44	50	0	,,
7th	,,	30·24	,,	50	44	47	0	,,

Note.—From the above figures the average figures for pressure and temperature and the total amount of rainfall for the week in question can be easily obtained.

SECTION III

WEATHER REPORTS

Every country in the world maintains a Meteorological department whose business it is to keep daily and other weather records, forecast weather and to publish daily and other weather reports, charts and maps.

The Indian Meteorological department was established in 1875 and its efficiency is well-known. We now possess a far better knowledge of our weather and climate than many other tropical countries.

The department maintains a network of observation stations throughout the country. Each of these stations makes one or two daily reports to its central office at Poona. The time of observation is 8 a.m. fixed internationally.

When the observation hour draws near the observer goes out and notes the state of the sky, the amount and the type of cloud, whether it is raining or showering, whether the visibility is good or bad. He makes an estimate of the direction and strength of the wind unless he is provided with an anemometer or a wind recorder from the records of which he can take the information. He then goes to his thermometer screen and reads the temperature, and then to his rain-gauge and measures the amount of rainfall. Then he sends his readings in code to the Head Office at Poona.

At the same time the ships in the Indian seas also record their observations and in sending their readings also record the position of the ships. These readings are at once entered on the weather map which is later on used by the forecaster. A summary of the daily weather conditions is broadcast as well as published every day.[1]

The Indian Meteorological Department publishes the Indian Daily Weather Reports. The first page contains a summary of observations recorded at 8 hours, giving weather forecast until the next evening. The second page contains three maps, the first containing the pressure, winds and rainfall conditions for that particular day at 8 hours. The second shows the pressure departure at 8 a.m. of day from normal ; and the third contains the departure of mean temperature of day from normal. The third and fourth pages also contain useful statistics for us. They contain observations recorded at 8 hours (local time) each day. The observations are taken at many places. A map showing the weather conditions of the previous day is also given for the purposes of comparison. Below are given the details of the different columns.[2]

Col. 1 shows the Barometer readings at 8 a. m. reduced to 32 standard gravity at sea or other standard level. These readings are the data from which the isobars showing the atmospheric pressure at 8 a. m. are drawn.

Col. 2 shows the departure of the figures in Col. 1 from the normal of the day. This may show an increase or a decrease. The readings of this column are used in drawing map No. 2.

Col. 3 shows the wind direction at 8 a. m. In the map the directions as well as the speed of the wind is shown. These are indicated on the map by arrows and the number of the feathers shows the strength or velocity of the wind according to a scale given above the map ; a calm is represented by a cross.

Col. 4 shows the visibility at 8 a. m. This factor, however, is not shown in the map to avoid overcrowding.

Col. 5 to 10 give the temperature details of the air in shade at 8 a. m. Col. 5 shows dry bulb temperature at 8 a.m. and 6 shows wet bulb temperature at the same time. The use of these two columns is to find out the effect of the rainfall on temperature. Col. 7 shows the maximum of the past 24 hours and Col. 8 shows the departure from the normal maximum of the day. Col. 9 shows the minimum of the last 24 hours and Col. 10 gives the departure from the normal minimum of the last 24 hours. The mean of the maximum and the minimum represents approximately the mean temperature of the the day. In the map No. 8 is shown the departure of the mean temperature of day from normal. This is − or +.

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[1] Owing to war these publications have been suspended temporarily.

[2] The student should refer to the old weather reports stocked in his College.

Cols. 11 and 12 show the relative humidity of the air at 8 a. m. and its increase or decrease since the same hour of the previous day. As a rule humidity tends to increase when the temperature falls and it decreases when the temperature rises. The degree of actual dampness of the air is called the 'Relative Humidity' of the air. Thus, if we represent saturation point as 100, and say that the relative humidity of the air at a certain place is 50, we mean to imply that the air at that place can hold twice as much water vapour as it is actually holding at that time.

Col. 13 gives the estimated cloud proportion at 8 a.m. on the scale 10 to 0. 0 means a cloudless sky and 10 signifies one entirely 'overcast'.

Cols. 14 to 18 show the rainfall data; the 14th shows rain measured at 8 a. m. that had collected in the rain-guage during the past 24 hours; and the 15th shows the amount of rainfall since the 1st of that month. The 16th shows the departure from normal for the same period and the 17th shows the amount of rainfall since the beginning of the running year. The 18th shows the annual normal. Rainfall of the past 24 hours is shown in the map by a small circle over the position of the station with an inscribed figure if the rainfall has increased ¼. The blank means ·10 to ·17, ·0 to ·09 being neglected.

Col. 19 shows by a single word or a short phrase description of the general character of the weather during the last 24 hours.

If you study the maps and also the figures you can very well understand the weather conditions of a certain day for which the report is meant. By a study of the maps for the whole months, you can very well gather the weather conditions during that particular month and so on.

Refer to the chapter on the reading of weather maps for further details.

The chief idea behind studying these reports is that you may know how to read weather maps and use climatic data.

SECTION IV

CLIMATIC REGIONS

Previously you have been told something about climate and weather and their various details. Now we have to apply these principles and find out into how many climatic regions can we divide the world. Temperature Zones have already been described. A climatic region means an area in which the climatic averages are the same at all the points approximately. Study the map on the *frontispiece*.

(1) *Equatorial Regions*—These intensely not and wet areas are found near about the Equator and extend to about 5°N. and S. of it. The temperature is uniformly high all through the year on account of the fact that the sun is never very far away from the Zenith. The annual range is only obout 5°F. The Diurnal or Daily Range of temperature is about 15°F to 25°F.

The great heat causes great evaporation to go up in the air which is always rising. Consequently heavy convectional rains take place all the year round. Below are given figures of Manaos for your careful perusal.

Manaos (3·14°S and 148′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Tem.	80.6	80.4	80.4	80.4	80.4	80.8	81.1	82.0	82.4	82.9	82.6	81.0
Rainfall.	8.3	8	8.1	8.4	6.6	3.9	1.8	1.3	2.2	4.6	4.5	8.2

(2) *Sudan Type.*—This type is also called tropical continental or Savanna Type. It is found on the north and south of the Equatorial type. The temperature is on the average high throughout the year but the difference between summer and winter is quite marked, the annual range of temperature being about 15 to 25. The daily range is relatively small.

This region comes within the range of the Equatorial convectional rains in summer and gets fairly heavy rains but in winters it comes under the influence of the dry trades. Study the given figures carefully.

El Obeid (13·16°N and 1866′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	67.8	70.5	75-8	83-2	85.7	84.7	80.8	79.1	80.2	81.4	76.2	68.8
Rainfall.	0″	0″	0.1″	0″	0.4″	1.2″	3.6″	4.5″	3.4″	0.7″	0″	0″

(3) *Monsoon Regions*—The Characteristic features of these regions are a pretty uniform distribution and a small range of temperature and heavy summer rains with winter drought. The summers are hot and wet and winters are warm or even dry. The following figures speak for themselves :—

Allahabad (25°N and 307′ High)

	J	F	M	A	M	J	J	A	S	O	N	D
Tem.	61	66	78	88	92	91	85	84	83	78	68	61
Rainfall.	0.6″	07″	0.4″	0.3″	4.7″	12.0″	11.1″	6.4″	2.2″	0·3″	0″	0·2″.

(4) *Hot deserts.*—This is also called Sahra Type. As is apparent, this region receives little or no rainfall. Such regions are found in the high pressure belts around the tropics of Cancer and Capricorn. The temperatures are high in summers, and winters are mild. The daily range of temperature is very big because of the dryness of the soil. Study the following figures.

Timbuktu (16·37°N and 1257′ High)

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	49 1	58.6	61.5	70.5	77.0	87.6	93.4	91.4	84.6	72.1	58.6	49.9
Rainfall.	0	0	0.1	0	0.3	0.9	3.5	2.8	1.1	0.4	0	0.1

(5) *Regions of the Ecuador Types.*—It is a modification of the Eqatorial type due to altitude. Temperatures are lower but uniform and the rainfall is less than in the plains. The daily range of temperature is great.

Quito (0·14°S and 9350′ High)

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	54.5	55.0	54.5	54.5	54.7	55.0	54.9	54.9	55.0	54.7	54.3	54.7
Rainfall.	3.2	3.9	4.8	7 0	4.6	1.5	1.1	2.2	2.6	3.9	4.0	3.6

(6) *Mediterranean Regions*—Such regions are situated on the western margins of the continents between the latitudes 30 and 40. Trade winds blow here in the summer and Anti-Trades in the winter. The summers are hot, dry and sunny, the winter wild and wet. Annual range is about 30°F.

Lisbon (38.42°N and 66′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	49.3	52.0	54 1	56 5	60 8	66 4	70.2	70.2	68.0	61.5	56 5	50.7
Rainfall	3 5,	3.4,	3.5,	2.9,	2 0,	0.8,	0 2,	0.2,	1 5,	3 1	4.5	4.1,

(7) *Regions of the China Type.*—These regions have similar latitudes and winds but they are situated on the eastern margins of continents with the result that they

have rainfall during summers, winters remain dry. Summers are hot and winters cool.

Hong-Kong (30.8°N and 108′ High)

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	59.7	57.7	63.0	70.3	76.8	80.6	81.7	81.1	80.2	76.1	69.1	62.6
Rainfall.	1.4	1.1	2.6	5.5	10.2	15.1	11.4	14.0	11.5	4.5	1.6	1-3

(8) *Regions of the Turan Type.*—Such regions are represented by Turan, the lowlands of Asia stretching from the Caspian to the mountain barriers of central Asia. They have a continental type of climate and the annual range is large. Rainfall is low and falls mostly in summer.

Tashkent (41.30°N and 1610′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	30.0	34.2	47.1	58.1	69.1	77.4	80.8	77.0	66.6	53.6	43.2	36.0
Rainfall.	1.8	1.4	2.6	2.6	1.1	0.5	0.1	0.1	0.2	1.1	1.4	1.7

(9) *The interior Plateau Type.*—This is also called Iran type. It resembles the Turan type exceptthat owing to the altitude the summers are not so hot and winters are somewhat cooler. The annual and diurnal ranges are large. Rainfall is low and uncertain.

Tehran (35.41°N and 4002′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	33.6	42.3	48.1	61.3	71.3	80.0	84.9	83.2	77.4	65.3	51.3	41.7
Rainfall.	1.6	1.0	1.9	1.4	0.5	0.1	0.2	0.0	0.1	0.3	1.0	1.3

(10) *Regions of the Western European Type.*—They have an insular climate. Such regions are found on the western coasts of the continents in the permanent zone of westerlies. The summers are cool, the winters mild and rain falls all the year round but it is heavier in summer. The annual ranges of temperature are small. Sometimes the passing cyclones and the anti-cyclones bring about sudden variations of temperature and rainfall.

Paris (48.51°N and 164′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	36.5	39.0	48.2	50.5	56.1	62.4	65.5	64.4	59.0	50.5	42.8	37.2
Rainfall.	1.5	1.2	1.6	1.7	2.1	2.3	2.3	2.2	2.0	2.3	1.8	1.7

(11) *Regions of the St. Lawrence Type.*—The climate in such regions is extreme, the chief characteristics being the alternation of a continental winter and a maritime summer and a great difference in humidity in the two seasons. Compared whith the western margins, the rainfall is less and has a summer maximum.

New York (41.6°N and 0′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	30.3	30.6	37.7	48.5	59.4	69.0	74.5	72.8	65.8	55.2.	44.1	34.2
Rainfall.	3.8	3.8	3.5	3.3	3.5	3.4	4.1	4.4	3.4	3.4	3.6	3.3

(12) *Regions of the Prairie Type.*—Such regions are situated in the interior of continents specially in the Northern Hemisphere (as the land masses in the Southern are much narrower).

The climate is of continental type with big annual ranges of temperature. The rainfall is low with a spring maximum.

Winnipeg (50.0°N and 1492′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	-3.5	-0.5	15.2	38.7	51.5	62.6	66.2.	62.7	54.1	41.6	22.9	7.2.
Rainfall.	0.8	0.7	1.2	1.5	2.1	3.0	3.2	2.2	2.8	1.4	1.0	0.9

(13) *Regions of the Mountain Type.*—Elevation is responsible for a decrease in temperature. Both the daily and annual ranges of temperature decrease according to height. The windward slopes of the mountains have a heavy rainfall, but the sheltered valleys and 'intermont plateaus' are dry. There is a marked rain-shadow on the leeward slopes of the mountains.

There can be further sub-divisions of this type into (*a*) Altai type and (*b*) Tibet type. Their main difference lies in the annual rainfall factor. The following figures speak for themselves.

(*a*) Darjeeling (27.0°N and 7,376′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	40	42	50	56	58	60	62	61	59	55	48	42
Rainfall.	0.6	1.1	1.8	3.8	8.7	24.0	28.3	26.1	18.4	4.5	0.8	0.2

(*b*) Leh (34.0°N and 11,503′ High).

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	17	19	31	43	50	58	63	61	54	43	32	22
Rainfall.	0.4	0.3	0.3	0.2	0.2	0.2	0.5	0.3	0.2	0	0	0.2

(14) *Regions of the Tundra Type.*—Such regions have extreme climates. The winters are extremely cold and the summers are cool. The rainfall is scanty. The ground is almost permanently frozen. There is no necessity of giving any statistics in this connection as the region does not attract much human attention.

(15) *Regions of the Ice-cap Type.*—Such regions are found near the two poles. The climate is freezingly cold all the year round. Rainfall is practically absent and whatever it is, is in the form of snow.

CHAPTER V

BIOGEOGRAPHY

Geographical Distribution of Plant and Animal Life

(SECTION A)

(NATURAL VEGETATION)

Natural vegetation includes all vegetation, *e.g.*, forests, grasses, desert vegetation and shrubs that grow in different parts of the world as a natural course, unaided and undisturbed by man. It is, however, wrong to think that all vegetation exists to-day as it existed before human interference. Most of the land in suitable regions has been cleared for cultivation of suitable plants, hence *natural vegetation* is rare to be seen.

As is shown in the map showing the distribution of natural vegetation, the varieties and types differ from place to place. The chief controlling factors in the growth of natural vegetation are soil and climate (temperature and rainfall). A study of the natural vegetation of the world is useful in as much as it tells us the suitability of certain plants in certain regions and as it determines the population and the occupations of people in certain regions. That is to say that the vegetation map may be treated as a 'key map' for making occupation and population maps.

The ordinary plants that are included in vegetation may be divided into (*a*) Trees, (*b*) grasses and (*c*) bushes. As we see the chief difference lies in the length and the size of plants. The length and the size of plants depends, as has been said before, on the amount and distribution of annual rainfall and temperature conditions ; that is to say the chief climatic factors controlling the distribution of natural vegetation are (1) the amount of actual rainfall received and the length of the period during which it is received and (2) the length of the season having temperature conditions favourable for growth of plants.

The occurrence of the above three types, therefore, depends on these two factors. Trees as a rule are characteristic of regions where both rainfall and temperature are abundant to aid luxuriant plant-growth. Grasses and bushes are found in worse regions *i.e.*, relatively speaking. As we shall see later on, the three varieties mentioned above could be further sub-divided.

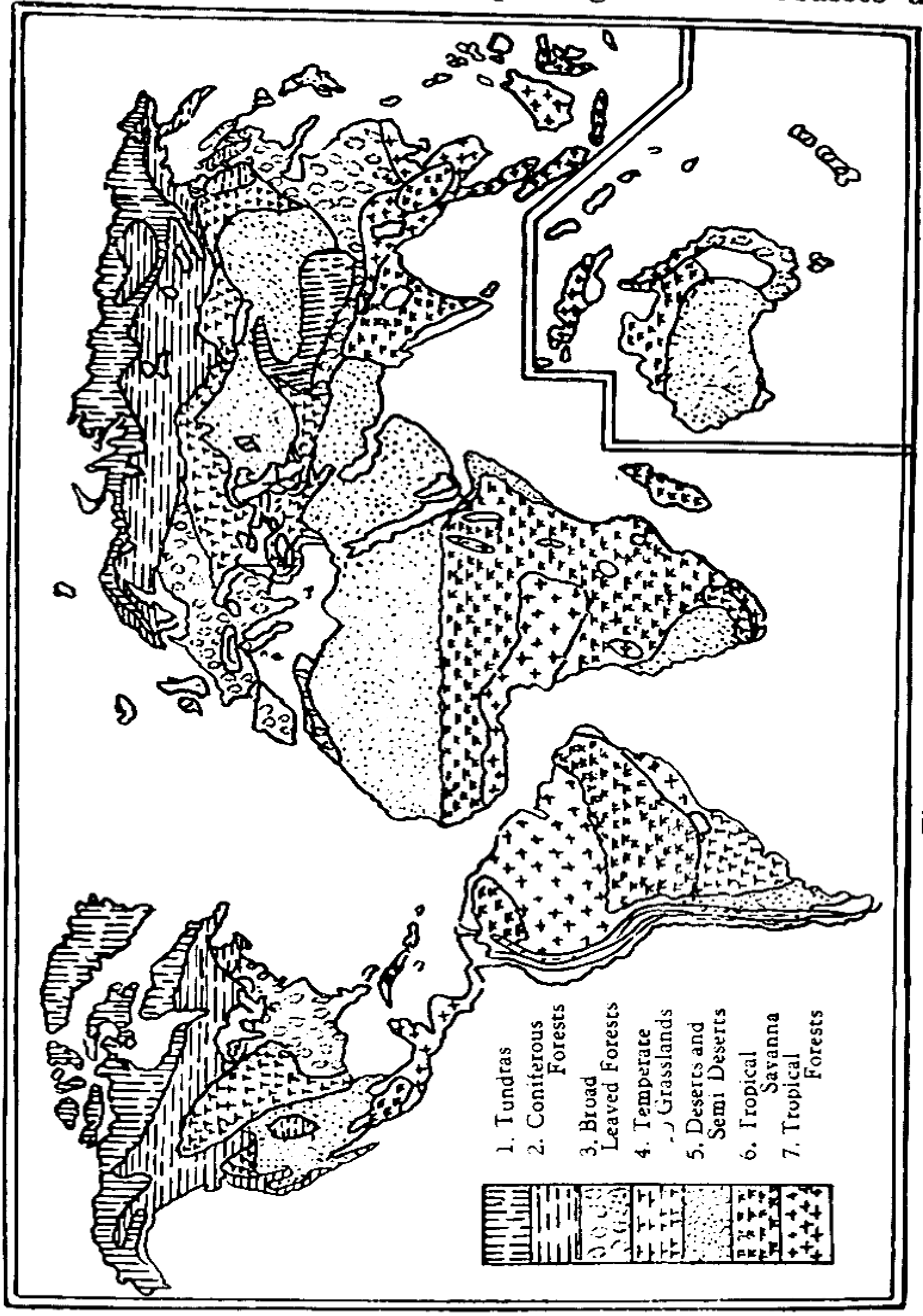

Fig. 81.—Vegetation Zones.

Distribution of Vegetation :—The map shows the actual distribution of natural vegetation. Seven main types are usually recognised. (1) Tropical Forest, (2) Tropical Savanna, (3) Desert and Semi-desert (4) Temperate grasslands, (5) Broad-leaved Forests, (6) Coniferous Forests and (7) Tundra and Mountain Vegetation.

These seven zones, however, may be expanded into the following eleven zones :

1.	Equatorial Forests.	Tropical Forests of the map.
2.	Tropical Forests.	
3.	Tropical Scrublands.	Tropical Savanna of the map.
4.	Tropical grasslands or Savanna	
5.	Deserts and Semideserts.	
6.	Temperate Grasslands or Prairies.	
7.	Sub-tropical Dry Forests	Broad-leaved and mixed forests of the map.
8.	Deciduous Forests	
9.	Coniserous Forests	
10.	Tundra and High Mountains	Tundra and High Mountains of the map.
11.	Polar Deserts	

Below we shall describe the expanded list of regions.

(1) **Equatorial Forests** are found within 7° North and South of the equator. The climate being hot and very wet, it is a region of very dense equatorial forests. Plant growth is tremendously luxuriant and trees sometimes grow upto more than 200 feet. Undergrowth too is abundant. The daylight is practically shut out by the huge trees. The population in these jungles is very sparse and people live only on the outskirts of the forests and on river banks. Very low conditions of civilization prevail here. The Amazon and the Congo Basins and portions of the East Indies and the Malaya are included in this zone.

(2) **Tropical Forests** are roughly situated within 7° N and S and 15° N and S. Uniformly high temperatures and a long rainy season covering about 7 to 8 months are the climatic characteristics of this zone. The trees as a rule, diminish in size and the undergrowth is not so abundant as in No. 1. In drier parts trees are even smaller in size and at places bushes become abundant. Most of these forests have been cleared for cultivation and many such regions are well known for their plantations of sugar-cane, rubber. etc. Population is quite dense but somehow the level of civilization is yet low. As this region is intermixed with the Equatorial forests, it is for this reason that in the map they are shown as one. Southern India,

and Indo-China are prominent tropical forest regions in Asia. In Africa such forests are found in Madagascar, Abyssinia and along the eastern coast. Central America and the Northern areas in South America are also important. Other regions having similar conditions are (1) drier parts of the East Indies and (2) a small portion in North Eastern Australia.

(3) **Tropical Scrublands** roughly fall within 10° and 20° degrees North and South of the equator and are often intermingled with the forests described above. Temperatures are usually quite high but the rainy season is rather short and hence the plant growth is relatively stunted. Bushes lose their leaves during the dry season. Moderate human activity is in evidence and population is also moderately dense. The level of civilization is generally low but at places *e.g.*, in Southern India, people are very civilized. The greatest expanse of this type of vegetation is found in central and central Southern Africa and Southern Mexico.

(4) **Tropical Grasslands or Savannah** are characteristic of regions that lie further ahead, about 15—25 degrees of latitude. Though the average temperatures are quite high but they are relatively lower and there is a definite dry and a definite wet season of roughly equal durations. Ordinarily these grasslands are practically treeless but at places specially near the equator, one comes across small trees and bushes. The most imposing expanse of these grasslands is found in Argentine (Pampas) and in Venzuela (Llanos.) The regions are full of grass-eating (Herbivorous) and flesh-eating animals. The region is not suitable for good cultivation and cattle-rearing in the most important occupation followed by the people. The density of population is not very low. Other important areas lie in South Africa (Kaffirs), and in tropical highlands like the Mexican plateau.

5. **Deserts and semi-deserts** :—Roughly speaking deserts and semi-deserts are more prominent between about 25° and 30°N. and S. where owing to high pressure, there is a descending movement of the air. Most of the deserts, however, lie on the western sides of the land masses as the trade winds give some rain to the eastern margins. Deserts also occur in the interior of continents in areas which are surrounded by mountains on all sides or at least on the windward sides. A good example of interior deserts is found in the desert regions of Central Asia.

Owing to intense dryness, the annual as well as the daily ranges of temperature are marked but the latter is much more prominent. On account of desert conditions, human activity is limited to the very minimum, more of it being present near the sources of water. These green spots that break the monotony of deserts are called *Oases*. In regions having better rainfall conditions, deserts become semi-deserts with their relatively better vegetation. The water-level which is very low in deserts comes up a bit in semi-deserts. Owing to the climatic conditions bushes are usually thorny as evaporation in such bushes is slower than in normal brood-leaved plants. All the species of plants have water-storing qualities and the same is reflected in the common animals like the camel.

Cold deserts occur on inland plateaus which are very cold because of their great altitude and very dry because of their situation in the interior of continents. Coarse, salty grasses and thorny shrubs constitute the chief vegetation of such regions. The great Basin in U. S. A. and Gobi Desert in central Asia are good examples of such deserts.

Population is practically absent in most of the true deserts except in oases, but in semi-deserts where it is possible to graze goats and sheep, population is comparatively denser but people are generally nomads wandering from place to place with their flocks in search of both human and animal food.

6. **Temperate Grasslands.**—The geographical distribution of temperate grasslands of the *Prairies* depends on rainfall and the kind of soil. It may be called a transitional zone between deserts and sub-Tropical forests. Broadly speaking they occur within 35° and 40°N. and S. The winters are cool and dry, while the summers are hot and wet. Owing to their continental situation, the annual range is marked. Prominent and useful stretches of grasslands occur in North America (Prairies), U. S. S. R. and Hungary (Steppes) and South Africa (Veldt).

Most of these areas are used for the cultivation of temperate crops like wheat, barley and oats. Drier regions abound in sheep and cattle. The Prairies and the Argentine regions supply wheat and meat to a large part of the world.

Population is dense and civilization is also pitched at a high level.

7. **Sub-tropical Dry Forests**—These are situated on the coasts of temperate lands between 30° and 40°N. and S.

They are called dry because the rainfall is not very heavy and the trees are of a hardy nature. The trees are comparatively small and are not situated close to one another thus making travel easier. Pine trees are characteristic of this region. Other trees that flourish in this region are laurel, olive, holly and live-oak. As the rainfall takes place in winter, the trees are usually evergreen. Population is moderately high and in some regions civilization has reached a very high level.

The greatest expanse of these forests is found in the Mediterranean region, in Southern California, central Chile, S. W. of Africa and South-West of Australia.

8. **Deciduous Forests.**—These are found to the east of the Prairies where rainfall occurs usually in summer and hence the trees are usually hard-leaved. These are composed of the oak, elm, maple, poplar and chestnut that drop their leaves during autumn. The climate of these regions is very invigorating and most of the forests have been cleared for cultivation. Some of the countries situated within stand very high in industry and civilization and the population there is very dense.

These forests extend over western and central Europe, Southern Chile, Eastern North America, Eastern Central Asia, Eastern Australia and New Zealand.

9. **Coniferous Forests.**—These forests consist of evergreen trees having long, narrow leaves as pine, fir and larch. They are found mostly in Northern latitudes about 50°N. and S. and above. The conifers are able to stand the low temperatures that occur for most of the year and the lack of rainfall which usually takes place during short summers. The regions abound in fur-bearing animals and their trapping and hunting are the chief occupations followed by the people. Lumbering and pulp-making associated with such forests are also important. Great coniferous forests encircle the northern portions of North America, Europe and Asia. Some cultivation is carried on in the Southern edges of the forests.

10. **Tundra.**—Further polewards it is too cold for any vegetation and the ground is covered by ice and snow for many months during the year. The same conditions prevail on very high mountains and that is why these two regions are treated together. Some shrubs and lichens are found at places but they become scantier towards the poles. The reindeer is the chief animal and the only property of the people who are very few in number and who

move from North to South and *vice versa* according to season.

11. **Polar Deserts**—Going further on one comes to the regions of permanent snow where nobody lives and practically no vegetation of any description is possible.

SECTION B

ANIMAL LIFE

Animals also live in places and surroundings that suit them best. Climate and vegetation form the most important parts of the environment. Animals live in climates for which their physical equipment is suited and in vegetation zones where they can easily get their food (most of the animals live on plant food). Small animals in turn become food for flesh-eating animals.

There are two methods of approaching the subject of the distribution of animal life. The first and the better approach is to consider the distribution of animals in their relation to the geographical environment ; and the second is a study through 'animals groups.' For the purposes of our study we divide the matter into the following geographical groups :

(1) Animal life in the Forests ; (2) Animal life in Grass and Scrublands ; (3) Animal life in the deserts ; (4) Animal life in the mountains ; (5) Animal life in the Tundras; and (6) Animal life in the oceans.

(1) **Animal life in the forests.**—In the Tropical forests conditions are unsuited to animals. The climate is damp and unhealthy and the vegetation is too dense to allow free movement. Either birds, monkeys and apes live on the trees or big animals like elephants take shelter in these forests. Snakes, tree-lizards and insects also abound. On the outskirts and on the river-banks, ground animals like the hippopotamus are found. The watercourses abound in crocodiles and fish.

In the sub-tropical evergreen forests the species found are more or less similar to the above but ground animals like leopards and wild cats increase in number.

In the evergreen forests of the Mediterranean lands, animal life is not abundant. Wild goats and the wild sheep deserve mention.

In the broad-leaved forests, small animals like the squirrel, martens and stoats are chiefly found. Larger animals like the fox, deer and the wild bear are also found at certain places.

In the cold coniferous forests of the north, fur-bearing animals like foxes, squirrels, bears, wolves and minks are most important.

(2) **Animal life in the Grass and Scrublands.**—These regions are the abodes of hoofed animals (or ungulates) like antelopes, deer, horses, camels and in places sheep and goats. They act as food for the big beasts of prey like the lions, tigers and jackals. It is also in these regions that swift running-flightless birds like the emu, ostrich and rhea live.

The colours of the larger animals are so designed that they conceal them from their enemies and from their own prey. In the wet season and in regions of taller grasses, they can easily hide themselves. Most of them have horns and big teeth.

(3) **Animal life in the deserts.**—Deserts have very few animals. The hot deserts have only some insects and gnawing animals that live on dry scattered vegetation. In the oases one may come across grazing species of the grass and the scurblands. The camel which can live for many days without water and who has broad soft pads in place of hoofs, is specially suited to sandy conditions of these deserts.

In the cold deserts that usually occur on inland plateous, animals usually have a thick protective coat. The yak of Tibet, ox and wild sheep are the most common.

(4) **Animal life in the mountains.**—Very few animals live on high mountains. They have hard elastic hoofs that enable them to jump about on hard rock. They are usually very agile ; sheep and goats being the most agile. The Lamas and the Alpacas are well-known species in South America (Andes). Many are ground-living animals, and live in holes and burrows.

(5) **Animal life in the Tundras.**—In the true Tundra regions where there is only a short warm and ice-free period, many animals settle down during summer, while they move southwards into the coniferous forests during winters. Further North in the regions of permanent snow no animal life is possible except perhaps for the Polar Bear.

Reindeer is probably the only permanent animal in the Tundras with a sprinkling of the Arctic Fox, the Arctic wolf and the Arctic bear. Eskimo dog is also found in certain places.

(6) **Animal life in the oceans.**—Animal life is mostly confined to the shallower and warmer parts of the oceans as it is here that some sea-grasses grow and 'plankton' is

found and where small animals (like the fish that form food for bigger animals) live. Oceans may be divided into (1) The continental shelf, (2) the open-seas, and (3) the ocean depths, for the purposes of our study.

(1) Animal life is abundant on the continental shelf. Fish of all descriptions, Lobsters and crabs are amongst the chief animals. In colder regions seals, cod and whales are found.

(2) In the open seas, life gets scanty. A few fish that float on the surface, whales and dolphins are the most important animals. Below in the dark sea-water, beautifully coloured fish move about.

(3) Life is practically absent in the deep oceans.

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PART II

MAP—WORK

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CHAPTER I

SOME GEOGRAPHICAL DEFINITIONS

Before proceeding any further, it seems quite desirable as well as necessary that we acquaint ourselves with some of the more important Geographical terms which we may come across during the course of this book specially in the section on Map-Work. Definitions of maps, charts, etc., and their various types are given in Chapter II of this part. Below are given (*a*) Topographical Forms and (*b*) Technical Terms used in surveying, etc., (compiled from 'Notes on Map Reading'—1942 Indian edition—Published by the War Office).

(*A*) Topographical Forms

(*a*) *Basin.*—A small area of level ground surrounded or nearly surrounded by hills, and (*b*) a district drained by a river and its tributaries, *e.g.*, the "basin of the Genges."

Saddle or Col.—A neck or ridge of land connecting two mountains or hills. A col is lower than the mountains or hills it connects, and higher than the surrounding plain or valleys.

Crest.—The general line formed by joining the summits of the main ridge of a chain of mountains.

False crest.—The line along which a lower steep slope changes to an upper gentle slope.

Dune.—A hill or ridge of sand formed by the wind.

Estuary.—The tidal mouth of a river.

Escarpment.—An extended line of cliffs or bluffs.

Foreshore.—That portion of the shore between high and low water at maximum spring tides.

Gorge.—A rugged and deep ravine (I—Shaped Valley).

Main feature.—The important forms such as ridges, drainge systems, etc., which determine the shape of a country (sometimes called *salient features*).

Pass.—A road or track over a mountain range.

Plateau.—An elevated plain.

Re-entrant.—A re-entrant occurs where the hillside is curved inwards towards the main feature ; it is always found between two salients.

Knoll.—A low detached hill.

Salient or Spur.—A projection from the side of a hill or mountain running out of the main feature.

Undulating ground.—Ground which alternately rises and falls gently.

Watercourse.—The line defining the lowest part of a valley, whether occupied by a stream or not.

Watershed.—A ridge of land separating two drainage basins ; the summit or land from which water divides or flows in two directions. A watershed does not necessarily include the highest points of a chain of mountains or a range of hills.

This list is not exhaustive at all ; there are many common terms such as *hill*, *mountain*, *river*, *slope*, *island*, *cliff*, *ravine*, etc., which have already been defined.

(*B*) Technical Terms.

Bearing.—True bearing is the angle a line makes with the true North line. Magnetic bearing is the angle a line makes with the Magnetic North line.

All bearings are measured clockwise.

Contour.—A contour is an imaginary line on the surface of the ground at the same height above sea-level throughout its length. Contours may also be defined as the plans of the lines at which a water surface (of the ocean, for instance) would intersect the surface of the earth were it raised successively by equal amounts.

Contour Interval.—The difference in level between two adjacent contours (generally known as the Vertical Interval).

Detail.—All minor natural or artificial features of the ground or on the ground.

Fall of a River.—Its slope, usually measured in inches (or feet) to the mile, thus : 9 inches to the mile.

Form line.—An approximate contour ; a sketch contour.

Gradient.—A slope expressed by a fraction. Thus 1/30 represents a rise or fall of 1 foot in a distance of 30 feet.

Graticule.—A system of four-sided figures formed by lines which represent portions of meridians and parallels.

Grid.—A system of squares formed by lines which represent progressive distances east and north of a fixed origin.

Grid North.—The lines of a grid point nearly, but not quite, north and south, and nearly, but not quite, east and west. Those which run nearly north and south are grid North lines.

Hachures.—Vertical hachuring is a conventional method of representing hill features by shading in short disconnected lines drawn directly down the slopes in the direction of the flow of water on the slopes.

Horizontal Equivalent (usually written H. E.).—Is the distance in plan between two adjacent contours.

Latitude.—The latitude of a place is the arc of the meridian from the place to the equator, expressed in degrees at the centre of the earth.

Local Magnetic Attraction.—Is the deviation of the magnetic needle of a compass from its mean position, owing to the presence of masses of magnetic iron ore or of iron in the neighbourhood.

Magnetic Variation.—The angle between the true and the magnetic meridians.

It is called east or west variation according as to whether the magnetic north is east or west of the true north.

Meridian or Meridian-Line.—A true north and south line.

Magnetic Meridian.—A magnetic north and south line.

Orienting or Setting a map, plane table, photograph, etc., is the process of placing it so that its true north line points to true north.

Plotting.—The process of recording on paper field observations and measurements.

Ray.—A line drawn from the position of the observer, to represent the direction of an object.

Resection.—A method by which the position of the observer is determined by observing the bearings of or drawing lines from at least two previously fixed points.

Section.—The outline of the intersection of the surface of the ground by a vertical plane.

True North at a point is the direction of the North Pole from that point.

Vertical Interval (usually written V. I.) is the difference in level between two adjacent contours.

CHAPTER II

MAPS AND THEIR TYPES

Map-Work comprises of (*a*) *map-making* and (*b*) *map-reading*; and as such it is a very important part of geography, because geography without maps does not make any sense. Maps are a geographer's ' tools ' and without these tools he is as helpless as a sailor without his charts and compass.

A map is a proportionate representation (or picture) on a flat surface (*e.g.*, on a flat piece of paper) of the whole or part of the earth, as one would see it if he were looking straight down upon it from a height. It builds a permanent record of the various features of the earth surface.

A *plan* (or a Cadastral map) is a term that is usually used in connection with property survey, *e.g.*, the plan of a house or building. The scale of this plan is large.

A *chart* is a navigator's sea-map showing coastlines, rocks and shoals, etc. The term chart has been derived by the French word ' Carte ' which means a map. Although there is some overlapping between the meanings of ' map ' and ' chart,' chart is usually a record of the submerged portions of the earth's surface.

Types of Maps :—There could be two main divisions of maps : (1) Based on their scales and (2) Based on what they show.

(1) Accordihg to the size of their scales, maps are either (*a*) *Cadastral*, *i.e.*, drawn to a very large scale (upto 25 or more inches to a mile). A plan as mentioned before, is a map of this type, (*b*) *Topographical maps* which are commonly drawn on quite a large scale, anything from 1" to 1 mile to 4 or even more inches to a mile. They represent smaller areas and show greater details of relief, drainage, etc. The Survey of India have prepared such maps of nearly all of India and the adjacent lands. Standardized symbols known as *conventional signs* are used to show various items in the maps, (*c*) *Chorographical* maps, *i.e.*,

small-scale maps showing large areas of the world, showing only the salient, broad features, Our atlases contain such maps. (*d*) World maps drawn to very small scales to show the whole globe.

(2) Different maps are drawn to show different features. Otherwise great confusion may creep in. The following are the main types :—

(*a*) A map showing only the outline of an area, *outline map.*

(*b*) A map showing the surface features (relief or orography) by means of colours and contour lines.—A *relief map,* (A Physical map or an orographical map). Drainage is also shown therein. A *geological map* is supplementary to this.

(*c*) A map showing the political or administrative boundaries, towns, roads, railways and airways, etc.—A *political map.* The roads, railways and airways may also be shown in separate maps.

(*d*) A map showing details about the ocean beds (depths of oceans and seas) by means of colours. *Batby Metric maps.* Attempts have also been made to work out the contours of the sea bottom. These contours are called *Isobathic contours.*

(*e*) Usually (*b*) and (*d*) are combined in one map as the one does not interfere with the other and as both represent more or less the same thing, *i.e.*, the heights and depths from the sea-level—*Bathy-Orographic maps.*

(*f*) *Pressure maps* show the pressure condition and winds. Pressure is shown by means of isobars.

(*g*) *Temperature maps* show the mean annual or seasonal temperature conditions by means of isotherms or colouring. To show temperature by means of isotherms is, however, the best method.

(*h*) *Rainfall maps* show annual or seasonal rainfall. Only the average conditions are shown.

(*i*) A *weather map* (as issued every day by the Meteorological department of India), shows the weather conditions (Pressure, Temperature and Rainfall etc.), for a particular day, week or month.

(*j*) A *Vegetation map* shows the distribution of natural vegetation on the earth or any part thereof.

(*k*) Maps are also made to show the natural distribution of animal life both on land and in the oceans.

(*l*) A *population map* shows the density of population in the various regions of the world.

(*m*) An *ethnographic map* shows the geographical distribution of human races.

(*n*) A *linguistic map* shows the languages spoken in the various parts of the world. This is akin to (*m*).

(*o*) Maps are also drawn to show the distribution of Agricultural and Dairying areas.

(*p*) Maps are drawn to show the distribution of individual crops and minerals. The dot method is mostly in use for the former.

(*q*) *Commercial and Industrial maps* show centres of commerce, means of transport, centres of industries and ocean and air routes.

(*r*) Some maps show the geographical distribution of occupations.

(*s*) Maps are also made to show historical events,—*Historical Maps.*

(*t*) An *air map* is drawn in such a way that a pilot can easily trace on it the nearest route from one place to another *e.g.* the air map showing the shortest route from Britain to any of the countries excluding Australia, East Indies, Southern Half of South America and the Southern tip of South Africa.

Maps are of great importance for military purposes. *Gridded maps* are best suited for their purpose because they have to know the exact position of objects. These maps are covered with squares (just like survey maps), the grids continuing from one sheet to the other. The larger squares are sub-divided into smaller squares and so on.

CHAPTER III

SCALES

We represent the world and its various positions on paper by means of *maps*. By looking at a map one could easily see the shape of different land forms, and ocean masses etc. When an area is represented in the shape of a map, it is very much smaller than the actual area, but at the same time the map is proportionate in every detail to the region it represents. *It is drawn to a scale.* " A scale shows the proportion that the distance between any two points on a map bears to the distance between the same two points on the ground." Thus if the length between two objects on a map is one inch and the horizontal distance between them over the the ground is two miles, the scale is 1"=2 miles. Bigger the scale, greater details can be put in the map. The scale we choose depends on the size of our paper and also on the area to be mapped and the details to be shown.

The first step in the study of maps, therefore, is the study of the scale.

Scale is usually expressed in three ways :—

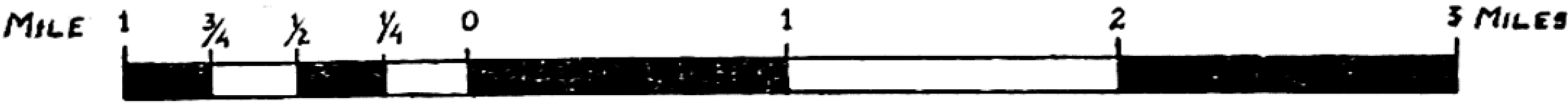


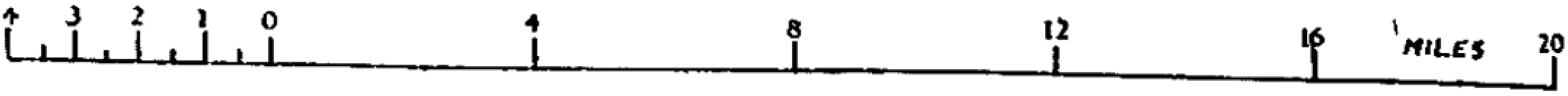
Fig. 1. Line scale.

(1) By a *statement* in words, e. g. 1 inch to a mile or 1 centimeter to one kilometer.

(2) By a *line* as shown in figure 1. From this line reduced distances may be measured directly. The line is divided into a number of equal parts or primaries, each part denoting a number unit, e. g. miles, yards, feet, etc. The first primary is further sub-divided into *secondaries* and is read from the zero to the left as shown in the diagrams showing scales. If all the primaries are sub-divided, the zero is put at the extreme left, it is known as a ***Fully Divided Scale***.

3. By a *representative fraction* or R.F., *e. g.* $\frac{1}{63,360}$ meaning thereby that one unit on the map means 63,360 units[1] on the actual ground. The unit used can be anything, inches, centimeters or any others. Actually $\frac{1}{63,360}$ is the same as 1″ to a mile, but a foreigner may not understand the latter as he may not know what a mile is. The formula of RF is :

$$\text{R.F.} = \frac{\text{Distance on map}^{(1)}}{\text{Distance on ground}}$$



R. F. $\frac{1}{253,440}$ (1″=4 miles)

Fig. 2.

(One Primary is equal to one inch.)

This is the best way of expressing a scale as the unit may be taken as anything and not only inches, feet or miles. A Japanese or a German map expressing its scale by methods (1) or (2) may be useless for us in this country as we may not be acquainted with their measurements, but if its scale is expressed as R.F., it is quite easy to be understood and can be converted into a line scale easily. Similarly it is quite easy to calculate R.F. from the statement of a scale. When we say ¼″ to 1 mile or 1″=4 miles the R.F.

$$= \frac{1}{63,360 \times 4} = \frac{1}{253,440}.$$

The scale of one millionth (1 :1,000,000 or 1/m) is an easy and useful scale to remember since 1,000,000 inches are about 16 miles (15·79 miles to be exact). It was decided in 1891 to map the world on 1/M (1 : 1,000,000) according to a common scheme. Great Britain and India have finished the mapping of their respective areas. The Indian series are 4×4 degrees. The scheme followed in other countries is 4° of latitude × 6° of longitude upto 60° and 4° of latitude × 12° of longitude beyond 60°.

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[1] The same units, e.g., 1″=63,360″.

In most of the atlas and wall maps, scale is expressed in all the three ways mentioned above.

While drawing scales, one very frequently has to divide lines into parts. It is quite easy to divide big lines accurately, but in the case of short lines, more accurate results may be had as shown in Fig. 3. XY is to be divided into ten equal parts. XL and YM are drawn perpendicular to XY. XL & YM are divided into nine equal parts and the corresponding points of divisions are joined as shown in the figure.

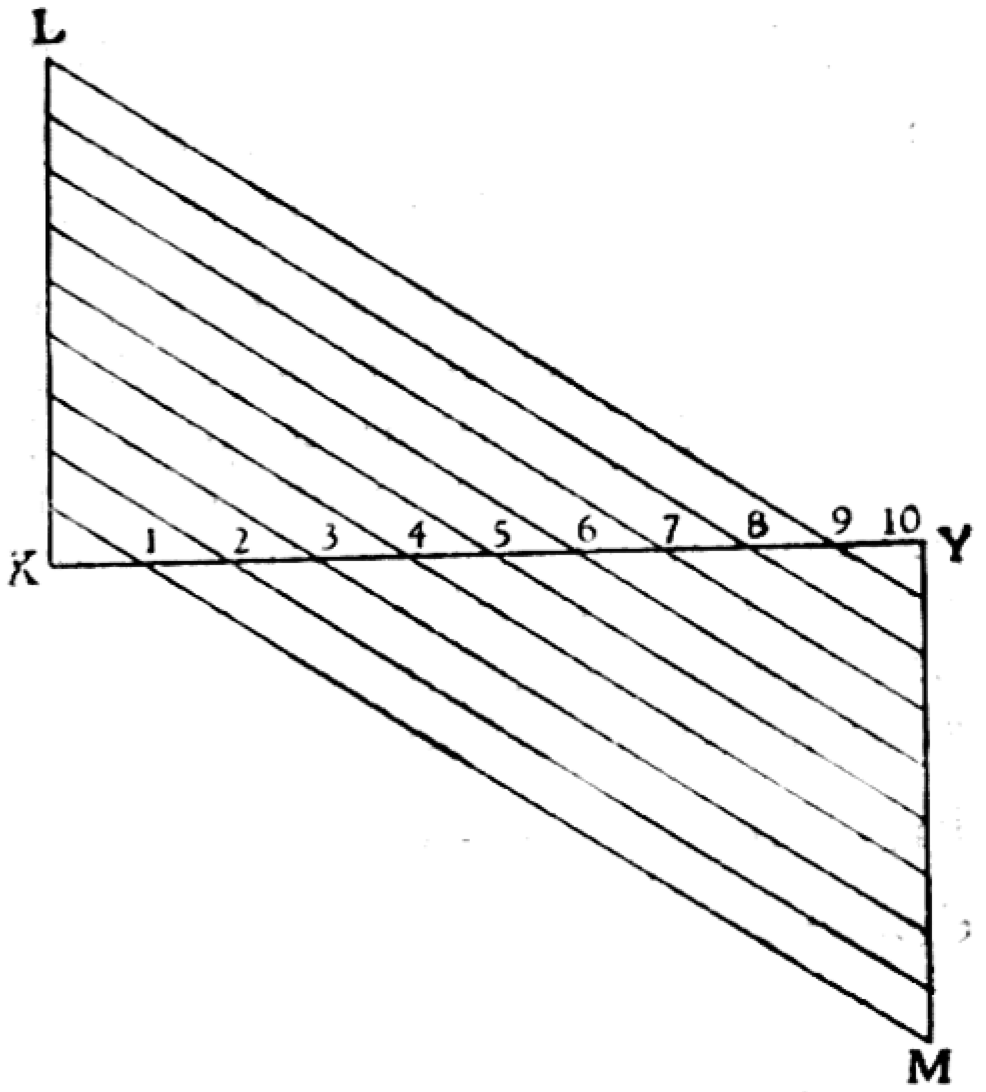

Fig. 3. Dividing a line.

Scale of time :—Fig. 4 shows a scale of time. These show distances covered in a given time. Besides, the time taken to move between specified places, may also be known at once from the map.

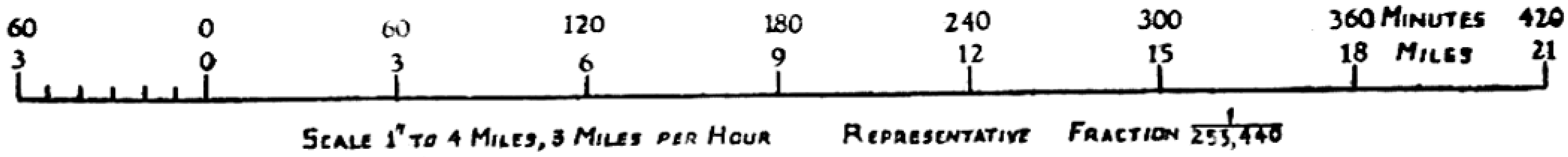
60
0
60
120
180
240
300
360 MINUTES
420
3
0
3
6
9
12
15
18 MILES
21
SCALE 1" TO 4 MILES, 3 MILES PER HOUR
REPRESENTATIVE FRACTION 1/253,440

Fig. 4. Time Scale.
(One primary is equal to 1″.)

The line shows both 24 miles and 420 minutes (or 8 hours). One sub-division shows an hour's march, *i. e.*, 3 miles in one hour. The left-hand primary is sub-divided into six parts to show the distance travelled in ten minutes.

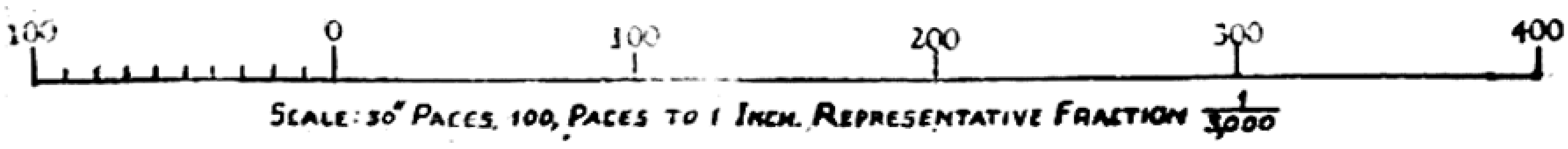
100
0
100
200
300
400
SCALE: 30" PACES, 100 PACES TO 1 INCH. REPRESENTATIVE FRACTION 1/3000

Fig. 5. Scale of paces.
(One primary is equal to 1″.)

Scale of paces :—Fig. 5 shows how a scale of paces is drawn. Sometimes (as during a rapid army march) one has no instruments to measure actual distances in inches, feet, yards or miles, etc. At such occasions measurements are made by pacing. An average pace is usually taken as equal to 30″. The scale shows 100 paces to an inch.

In inches it means 1″ = 8,000″. The R.F. is $\frac{1}{8,000}$. One has to acquire a lot of practice in pacing before he can reach any degree of accuracy.

Diagonal scale :—This is used to divide a primary into very small secondaries (*e. g.* one inch may be divided into 100 parts). This is, however, not possible with a ruler that we use. Even the best dividers may not be very accurate. The figure shows how a diagonal scale reading upto $\frac{1}{100}$th of an inch is drawn.

A scale line measuring one inch is drawn and on it a rectangle, as shown in the figure (or a square), is drawn. Now all the four lines are divided into ten equal parts as shown in the figure. First the divisions of the vertical lines are joined to form equal and parallel straight lines to the scale line. Then the divisions on the two horizontal lines are joined diagonally, *i. e.* 0 on the bottom line to 1′ on the top line, 1 on the bottom line to 2′ on the top line and so on.

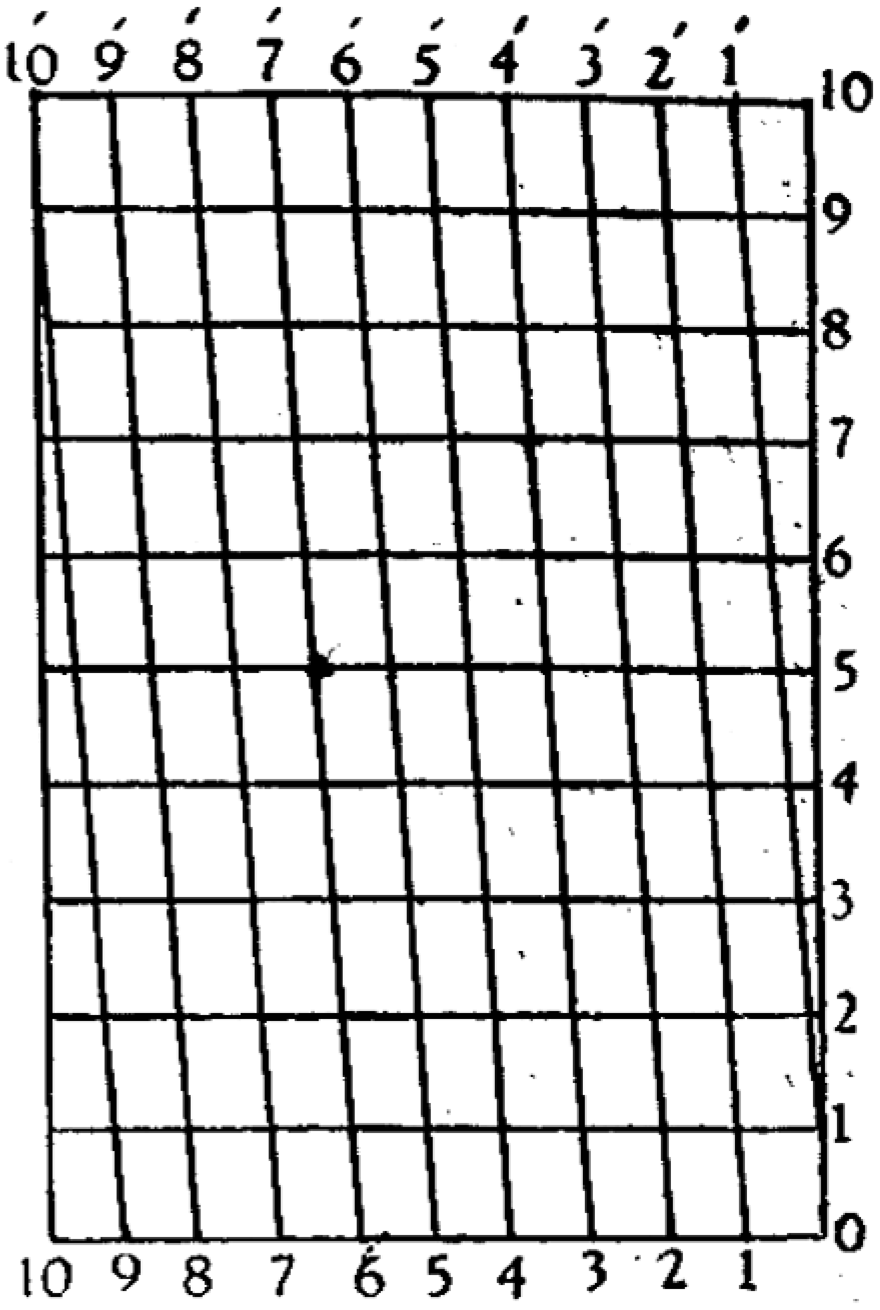

Fig. 6. A diagonal scale.

Now it is quite simple to read distances. Suppose we want to measure 0·65 inches. Start on the diagonal 6 on the scale line and go up to the line 5. The distance from this point to the right-hand perpendicular 0 is equal to 0·65 inch.

Besides the atlas maps, maps are either *large-scale maps* or *small-scale maps*. The latter meaning maps drawn on " six inches to a mile " or even more inches to a mile. In such maps even every house and every tree may be possible to be shown. These maps are usually used by building and road engineers, town councils, etc. The former mean maps drawn to one inch to a mile, four miles to an inch and so on. In these maps, (as are issued by the Survey of India) only the broader details like roads are shown. These are useful to motorists, hikers and tourists, etc.

Enlarging and reducing maps :—Allied to the question of scales is the problem of enlargement and reduction of maps. There are three common methods of doing this :

(*a*) The *photographic method*, with which we are all familiar. This method however, is highly technical and of little use to students.

(*b*) By means of a *Pantagraph* or an *Eidograph*. These are special instruments made for changing the scales of maps and are quite convenient to use once we are are familiar with them. The pantagraph is more commonly used and most of the college geography departments make use of this instrument.

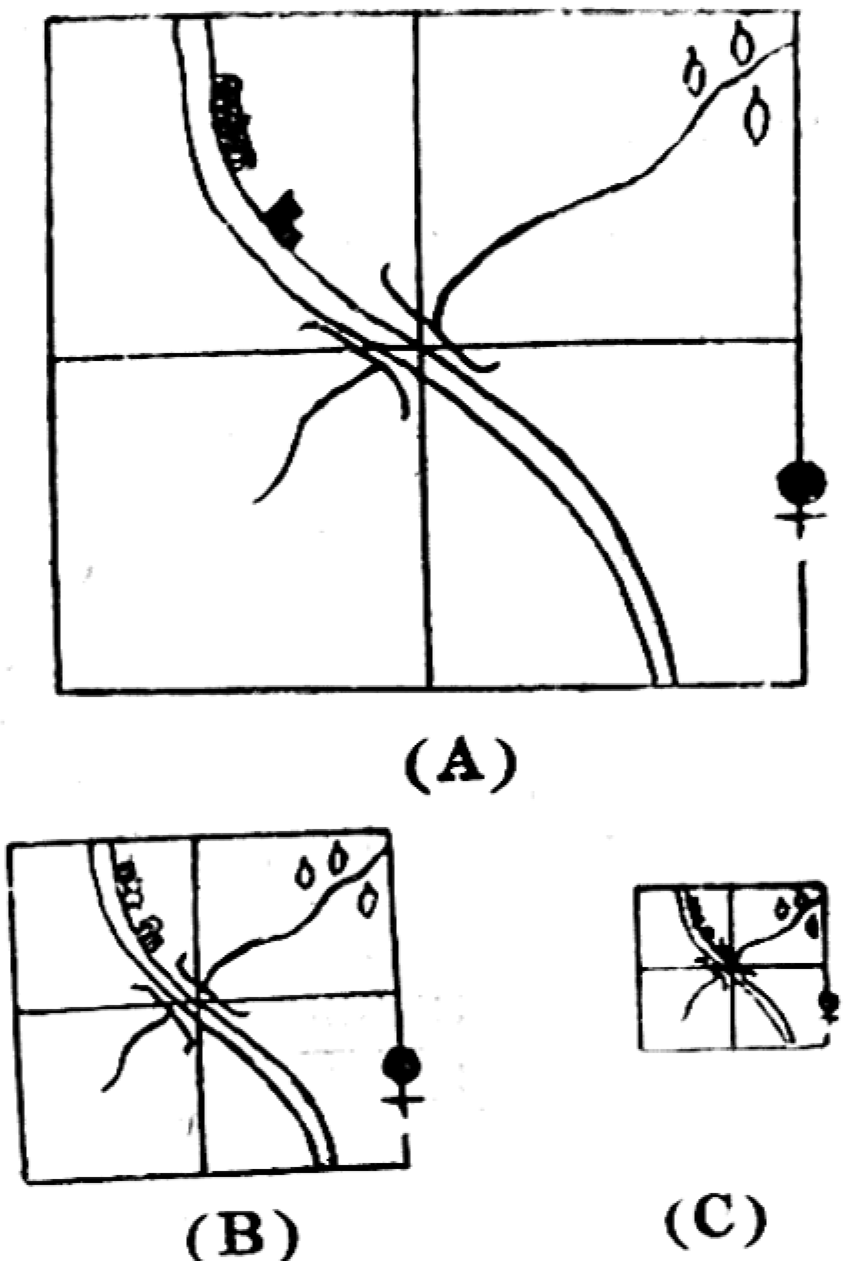

Fig. 7. B shows the original, A enlarged, and C reduced.

(*c*) *By a system of squares* :—For this purpose the original map has to be divided into small squares (better if diagonals are also drawn). Another set of similar squares is then drawn according to the requirements either on a smaller scale or on a larger scale. The points where the features shown on the original map cross the lines, are then transferred to the fresh set of squares by eye or otherwise and the map completed freehand. If the scale is doubled, the area is multiplied by four, if the scale is increased by four times, the areal increase is sixteen times and so on.

For greater accuracy in getting the details in the maps, diagonals may be drawn both in the original squares and in the reduced or enlarged ones. In an enlarged map, greater details may be filled in if the data is available.

The figure shows examples both of enlargement and reduction.

Combining of Maps.

If two maps of adjacent areas drawn originally to different scales are to be combined to form one map on a scale which may be different from either of the originals, it is better to choose some definite size of the square for the new map, and then to calculate the corresponding sizes on each of the originals.

For example, suppose two maps of two areas are available on the scale of 1 : 12,000 for the first, and 1 : 9000 for the second and that we require a map of the frontier region on a scale of 1 : 10,000. Choose centimeter squares for the new map and find out the size of the squares on the original maps, respectively.

Suppose x is the side of the sq. on the 1st map.

$$x : 1 : : 1 : 12{,}000 : 1\ 10{,}000$$

$$x : 1 : : \frac{1}{12{,}000} : \frac{1}{10{,}000}$$

$$x = \frac{\overset{5}{10{,}000}}{\underset{6}{12{,}000}} = \tfrac{5}{6} = \cdot 833 \text{ c.m.}$$

Suppose y is the side of the square on the second map.

$$y : 1 : : 1 : 9000 : 1 : 10{,}000$$

$$y : 1 : : \frac{1}{9{,}000} : \frac{1}{10{,}000}$$

$$y = \frac{10{,}000}{9{,}000} = \tfrac{10}{9} = 1{\cdot}1 \text{ c.m.}$$

Next we must choose some clearly defined point lying near the Frontier and shown on both the original maps. This should be the starting point for the squares in all cases and it must be taken as giving the direction of one side of the squares. If no such point is available the junction between two definite lines of latitude and longitude may be taken as the starting point; and North and South lines as the standard direction. The squares can then be drawn and numbered to correspond on both the original maps, and when the centimeter squares are drawn on the new map, the outlines can be put in at once on them.

CHAPTER IV

MAP PROJECTIONS

We all know that the earth is round. The paper on which we draw a map of the world or of any country is flat. In the making of a map the problem of representing an area upon a plane surface has to be faced. It is evidently impossible to do so very accurately. To meet this difficulty map projections have been devised with the idea of minimising such errors as may arise from any attempt to do so. Map projections enable us to represent them with relative accuracy.

The first and the most important thing in the drawing of a map is to draw the network of the parallels of latitude and the meridians of longitude (or *graticule*). When the same are transferred from the globe to the flat surface of the map, the process is called *projection*.

This is done in many ways and different types of projections are used for different maps. The thing that we require in a map are the directions, shapes and the area. There is, however, no such projection in which all of these facts may be correctly shown. We have to sacrifice the one for the sake of the other. There are the following main types of projections. It may be added here at this stage that you need go only into elementary details of their construction. If you simply know something about the chief characteristics of some of the more important projections, it should be quite sufficient for the present.

Projections are classified broadly as Equal-area projections—accurate in area ; equiangular projections (they are also called orthomorphic projections)—accurate is shape ; and equidistant projections—accurate in distance and relative positions. Some people classify projections according to the methods of construction used as cylindrical, conical and zenithal. What we shall study is a combination of these two main classes.

1. **Cylindrical Projections.**—In these the globe is enclosed in a paper cylinder just touching it at the equator, and the parallels and meridians are then traced on the cylinder. When the cylinder is unfolded, the equator becomes a horizontal straight line, the parallels of latitudes which are complete circles on the cylinder become straight lines equal and parallel to the equator.

The **Meridians** of longtude appear as equidistant straight lines perpendicular to the equator and parallel to one another. The scale of the map thus increases towards the poles which instead of being points are represented as straight lines parallel to and as long as the equator.

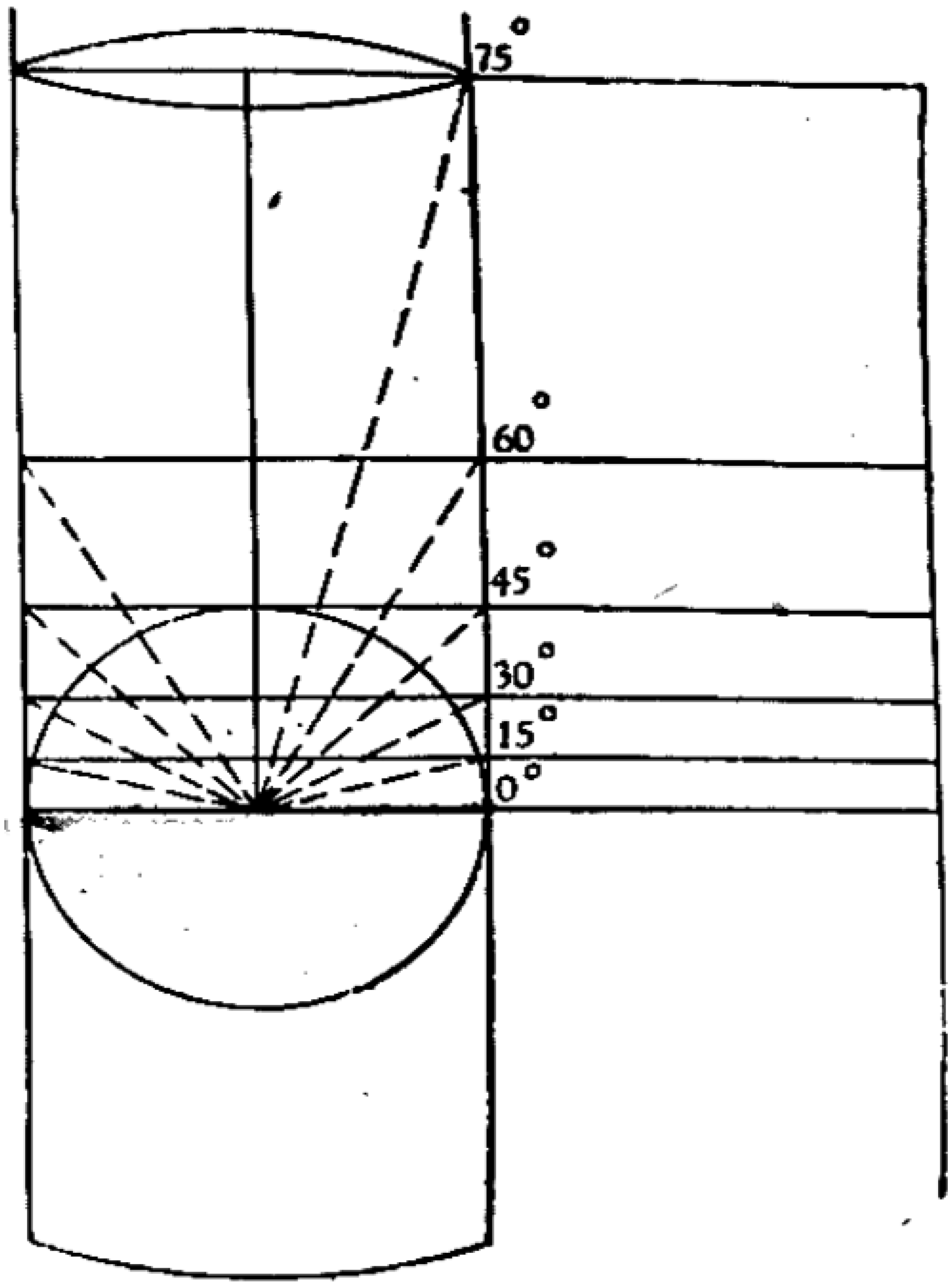

Fig. 8. Simple Cylindrical.

The best known cylindrical projection is the *Mercator's Projection.* It is an orthomorphic projection. The underlying principle is that in order to keep true proportions, the scales at any one point of the map have to be kept the same length along the meridians and the parallels and that both must meet at right angles everywhere. Consequently in the Mercator's Projection the scale along the meridian at each point is, therefore, increased in as much as it is stretched along the parallel. As an example the latitude scale is doubled at 60°. In the Mercator's Projection therefore,

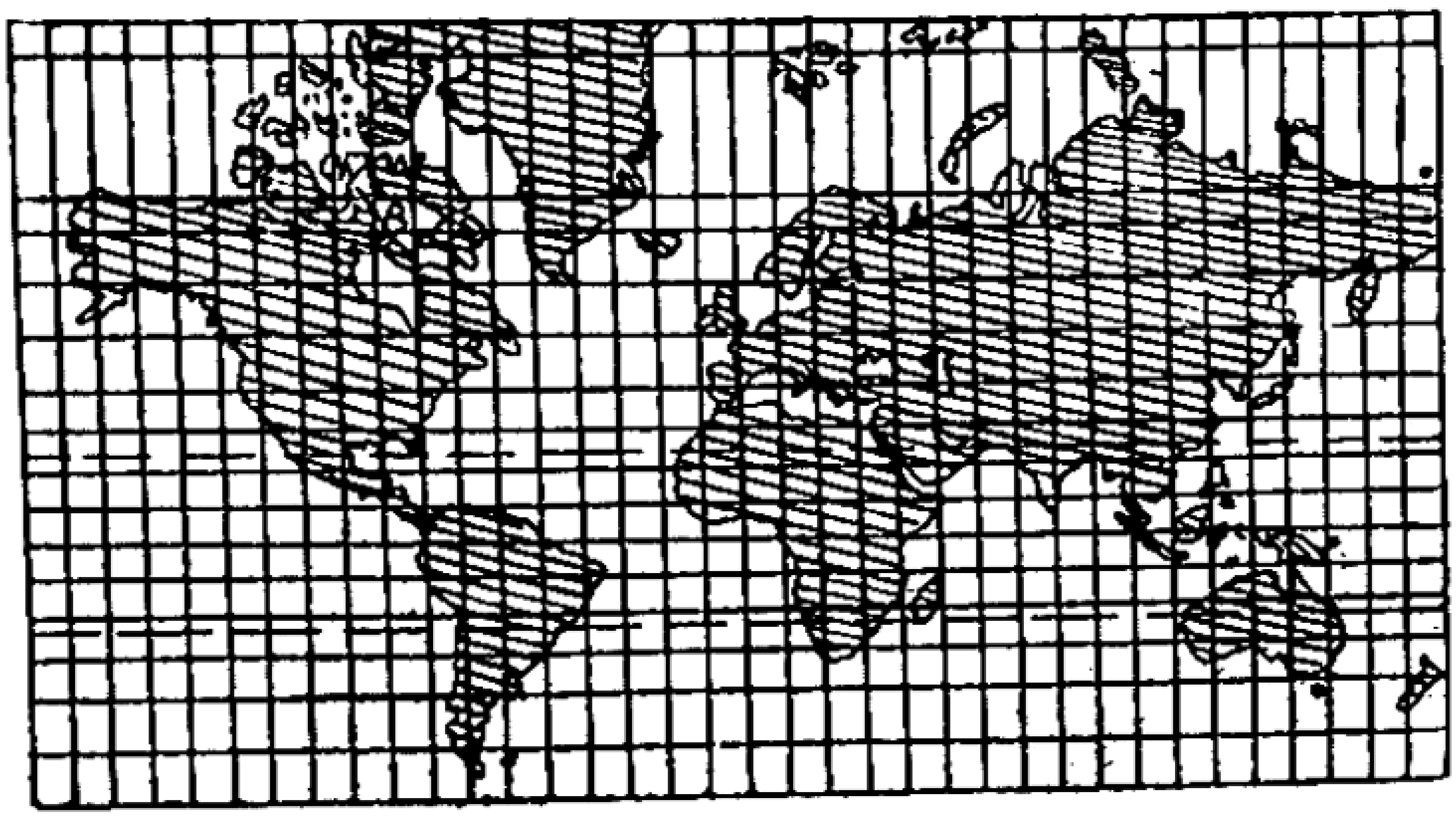

Fig. 9. The world on Mercator's Projection

the meridian scale there is also doubled. As a result of all this stretching and doubling the areas are much exaggerated specially towards the poles but the shapes are correct and the directions are also true. Study the given map of the world on Mercator's Projection and see for yourself how areas are exaggerated. Greenland about one-twelfth of South America, appears somewhat larger than that continent. This projection, however, is useful for navigation and for drawing maps of ocean currents and winds, etc.

Another modification of the cylindrical projection is the *Sinusoidal* or the *Sanson-Flamsteed Projection.* In order to do away with the exaggeration in areas each parallel is made to correspond with its exact length on the globe. The parallels are then divided on both sides of the central meridian into, say, eighteen equal parts. The parallels are equidistant along the central meridian. Naturally, therefore, the meridians are curves through the division points. This projection is, therefore, true in area and is generally used for statistical and distribution maps. It is, however, not orthomorphic and shapes are increasingly distorted specially at places away from the equator and the central meridian. This projection is in much use for Africa and South America. It is specially suitable for them as they neither extend too far north or south of the Equator nor too far east and west of the central meridian.

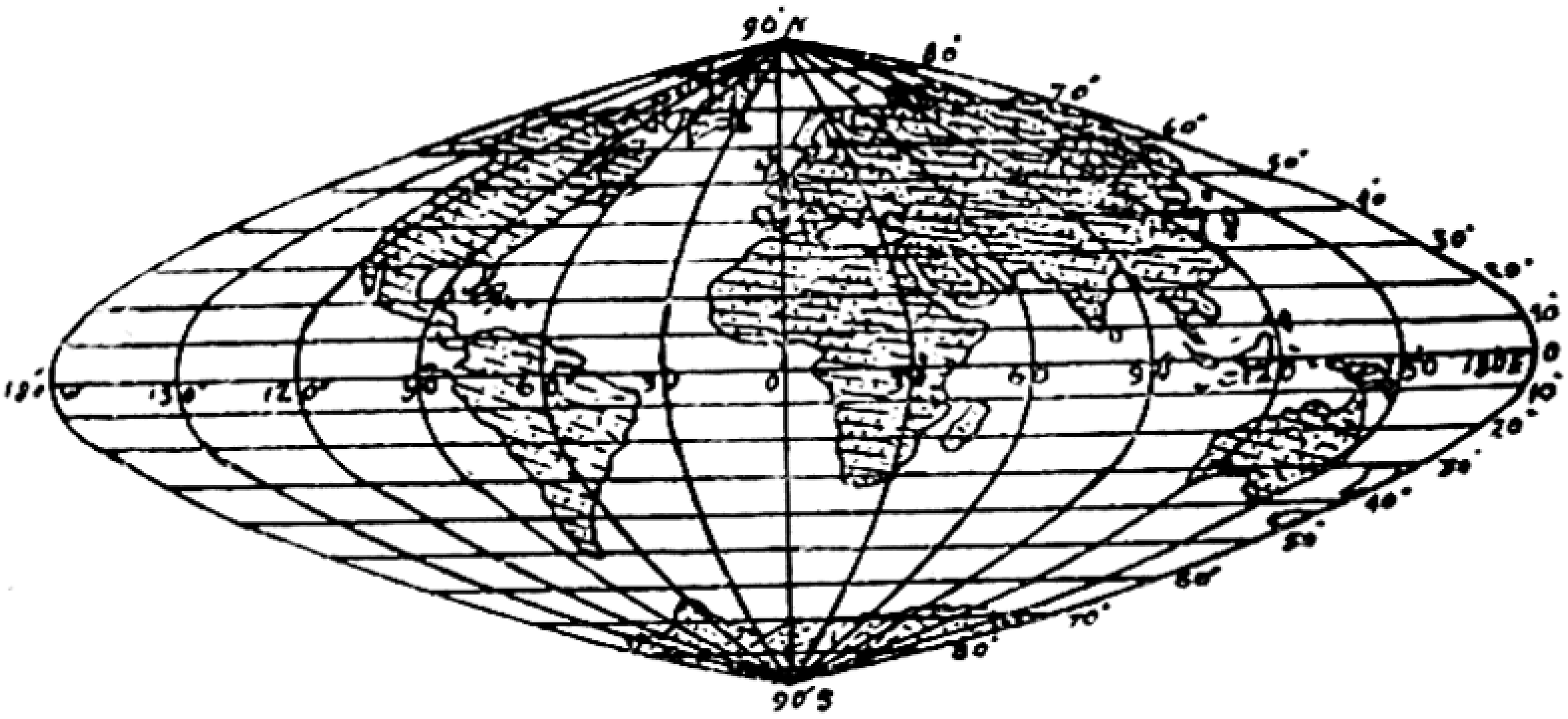

Fig. 10. The world on Sinusoidal Projection.

2. **Conical Projection.**—In this projection a sheet of paper folded into a cone rests on a glass globe so that its zenith or apex is over the North Pole or over the apex of the area to be mapped. The globe has a light in the centre and the parallels and meridian are made in thick black. The shadows then are projected on the cover and are traced. The cover is then unfolded. In this the meridians of

longitude are straight lines diverging from a common centre and the parallels of latitude form arcs of concentric circles. The cone can be fitted over any part of the globe and the network of the parallels and the meridians of the area drawn. The cone touches the globe at the central parallel of the area. This central parallel is referred to as the 'Standard Parallel.' This parallel is transferred on to the paper and is then divided into required' number of equal parts and through the dividing points meridians are drawn. The remaining parallels of latitude are then drawn equidistant to each other and parallel to the standard parallel. This projection is neither truly an equal-area projection nor a true orthomorphic projection. It is rather a compromise between the two. The distortions increase as we move farther away from the standard parallel. Therefore maps of only those countries which have no wide ranges of latitude can be correctly drawn on this projection. This projection is best suited for maps of Europe, the British Isles, North America specially U. S. A. and Australia.

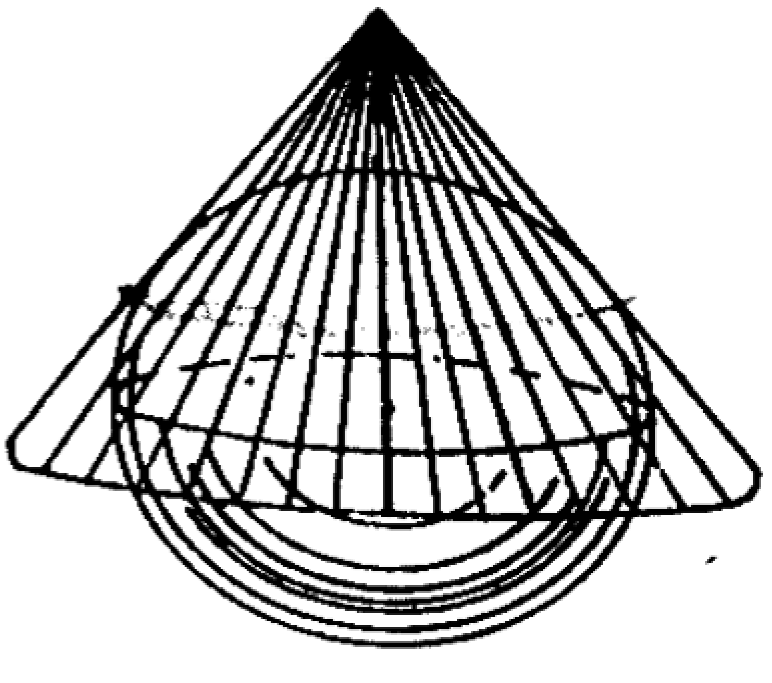

Fig. 11. The idea of simple conical Projection.

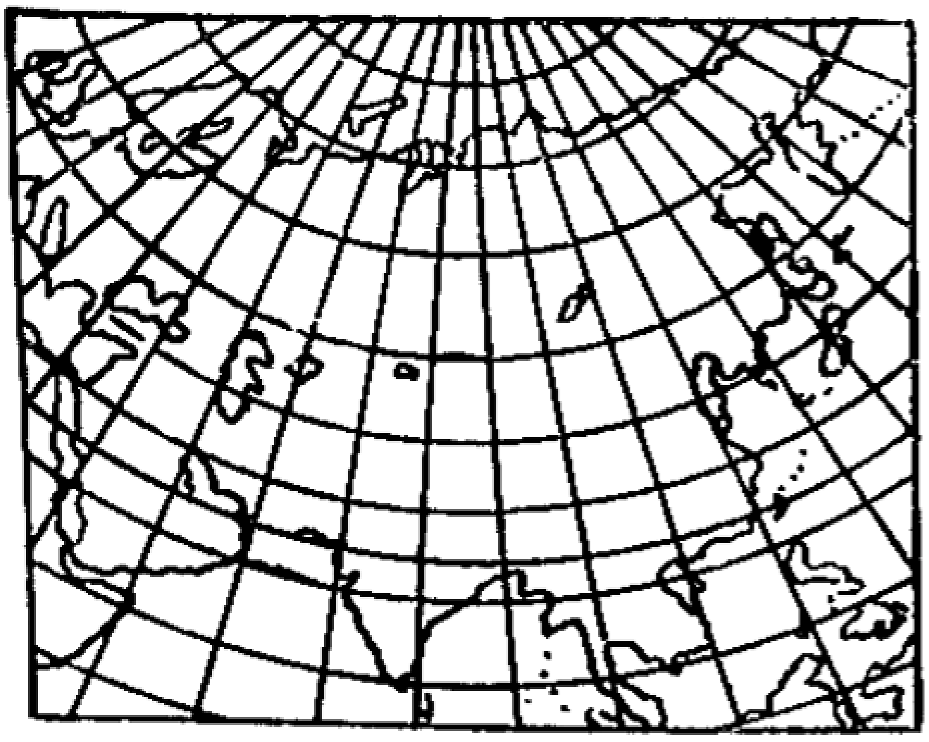

Fig. 12. Asia on simple conical Projection.

A useful modification of the simple conical projection has been made in *Bonne's Projection*. The central meridian is drawn perpendicular to the centre of the standard parallel and the remaining parallels are arcs of concentric circles cutting the central meridian at equal distances. Each parallel is then divided into equal parts corresponding in total number to the number of meridians required and a meridian is drawn from the Pole to the Equator through each of these points. In this projection both the parallels and meridians except the central meridian appear as curves and the meridians become closer together near the pole. This projection is equal-area but not orthomorphic and is used for maps of smaller countries having a narrow longitude range and being situated away from the Poles. Palestine is the best example.

Another important modification of the simple conical projection is the *conical projection with two standard parallels.* The two standard parallels are obtained by 'sinking' the cone into the globe. The standard parallel of the simple conical projection lies in their middle. This projection is both equal-area as well as an orthomorphic projection and is, therefore, quite a correct and useful projection type. It is used for small countries like the British Isles. Maps of bigger areas are, however, drawn more correctly than on the simple conical.

'Polyconic' and 'International conical' projections are other modifications of the simple conical projection.

or Zenithal projection.

3. **Hemispherical Projections.**—As the name signifies these types are used for mapping the hemispheres. In these projections the map is supposed to represent the view one would have of an area of the earth outlined on a transparent globe. The view is taken from various situations and according to these the types differ. The most important are the zenithal projections. These zenithal projections have three important sub-divisions, *viz.*, (*a*) Stereographic, (*b*) Gnomonic and (*c*) Orthographic.

The zenithal projections have their graticule (network of parallels and meridians) drawn directly on a sheet of paper that touches the globe at the centre of the map. These projections are usually 'polar,' the pole being the centre of the map where the paper touches the globe, and the parrallels becoming a series of concentric circles about the pole. We can also draw zenithal projections with the tangent-planetouching the globe at the Equator or any other intermediate point. The latter are called 'oblique' and the former 'Equatorial Zenithals.'

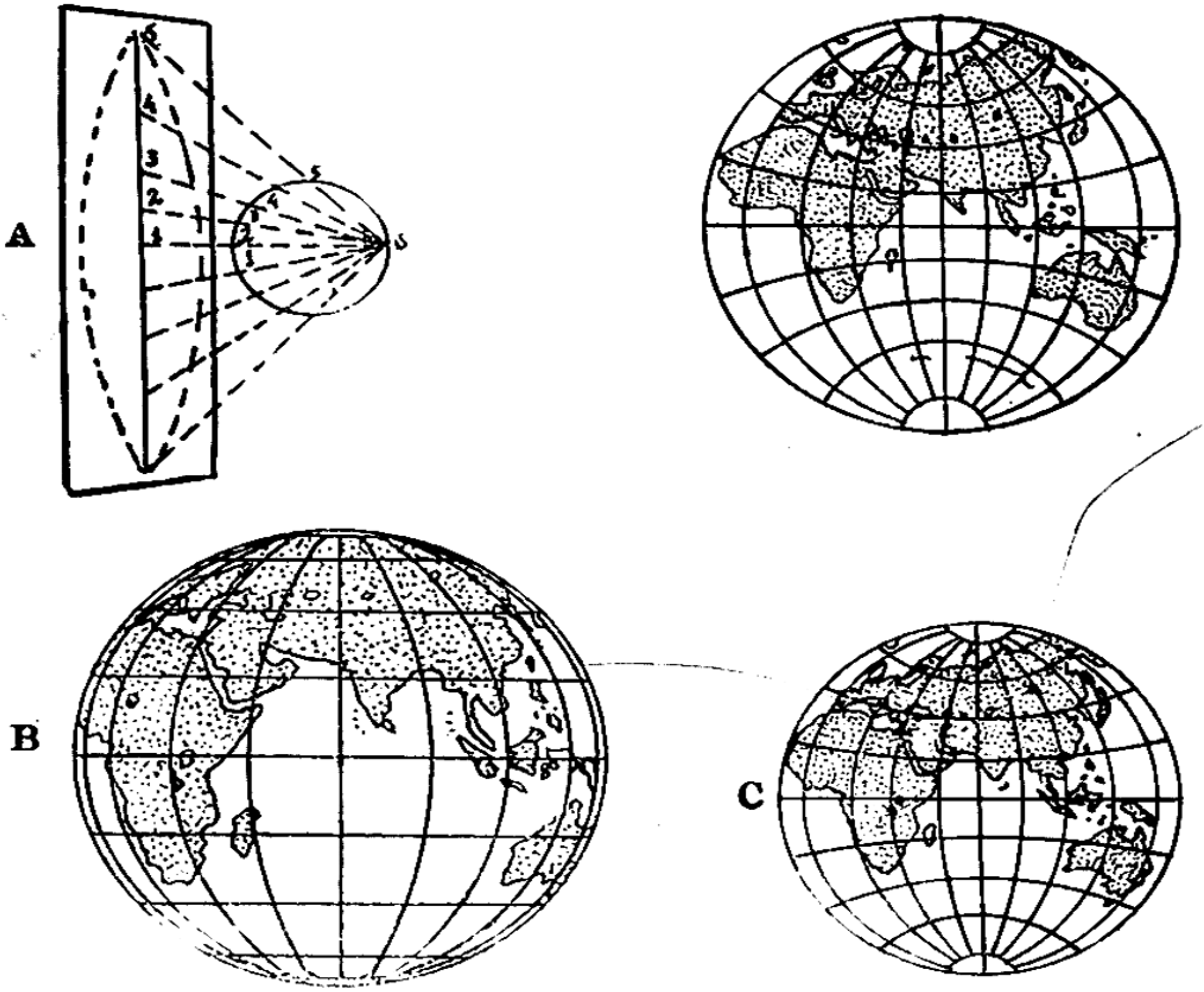

Fig. 13.
(A) Stereographic Projection. (B) Orthographic Projection.
(C) Gnomonic Projection.

The three main types of zenithal projections described above are different only in the position of the point from which the network is projected on the tangent-screen. In the 'Stereographic' projection that point is on the edge of the opposite hemisphere on the other end of the diameter of the globe. In 'Gnomonic' it is at the centre of the globe and in the 'orthographic' it is at infinity.

Out of all the three only the 'Stereographic' is orthomorphic. The Gnomonic is very useful for great-circle sailing. The orthographic projection is not true for areas, shapes or distances except for a small part in the centre of the map and is used only for astronomical purposes.

It may be added in conclusion that hemispherecal maps can be made with any part of the globe as the centre point. Polar regions may be mapped with the North and South poles as the centre points.

4. Other projections that may be mentioned are *Globular* and *Mollweide's*.

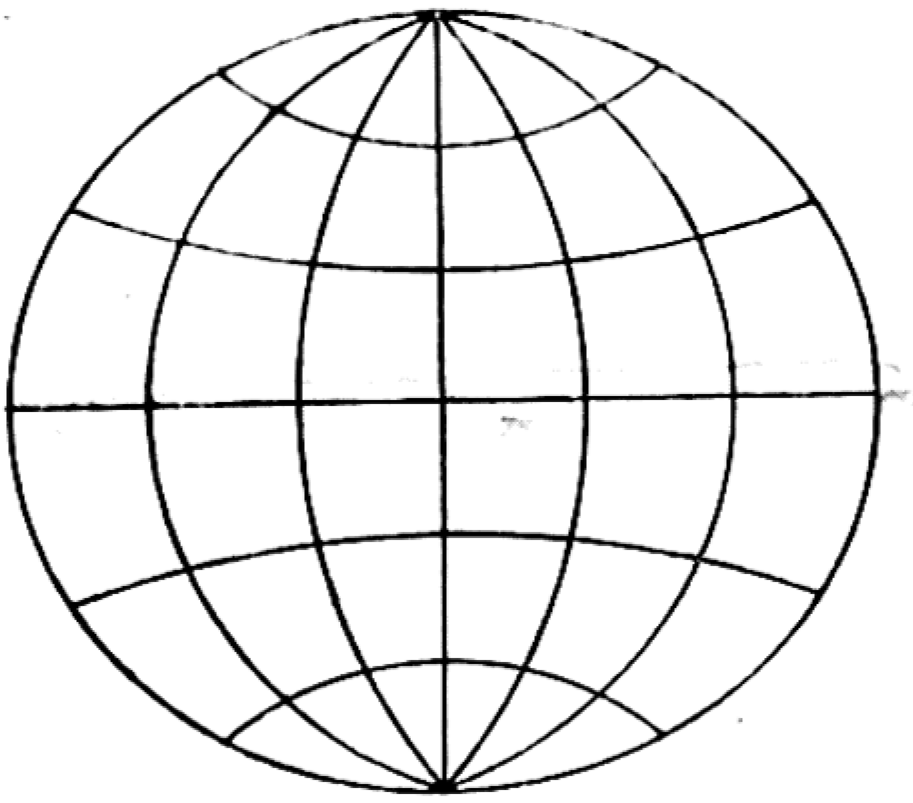

Fig. 14. The idea of Globular Projection.

(*a*) The *Globular projection* has no particular characteristics and is purely an 'arbitrary projection.' Its only good point is the simplicity of its construction. A circle is drawn to represent a hemisphere. The horizontal diameter represents one-half of the Equator and the vertical diameter the central meridian. The equatorial diameter is divided into any number of equal parts to show degrees of longitude. In the same way the central meridian is divided into equal parts to represent degrees of latitude. Then the nework is completed as given in the figure.

(*b*) The *Mollweide's projection* is an equal-area projection and is an improvement of the 'Sinusoidal' projection.

[illegible]

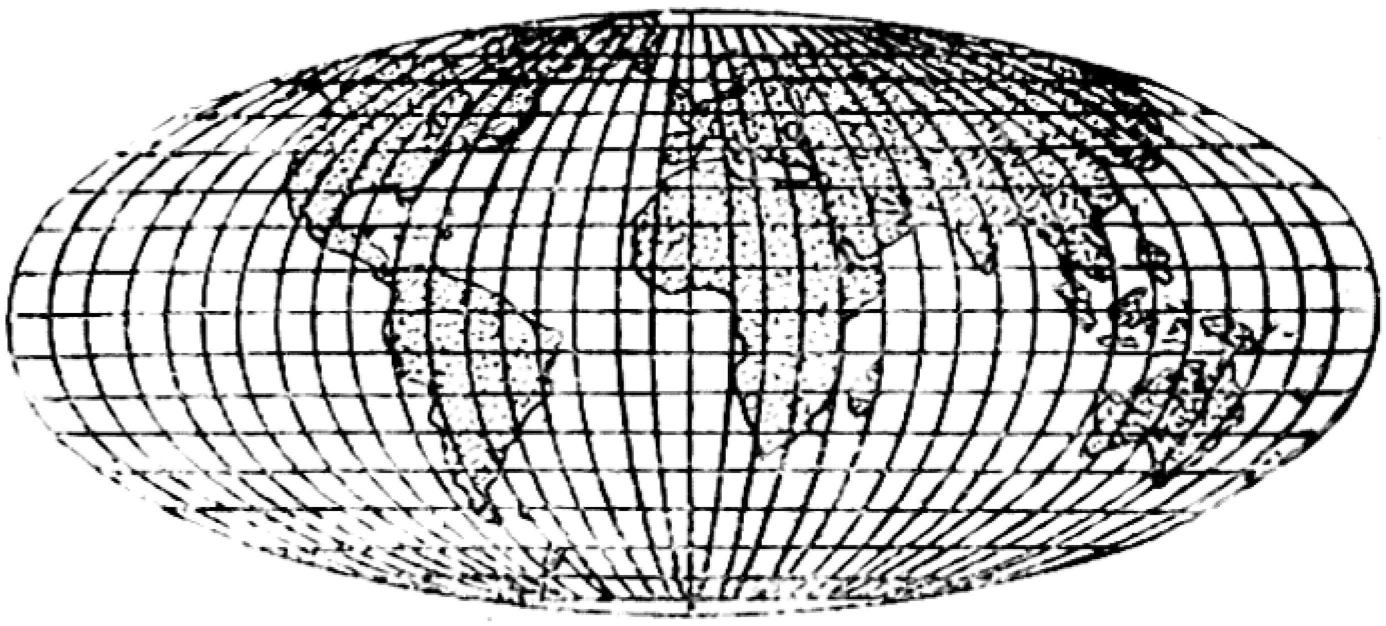

Fig. 15. The world on Mollweide's Projection.

The globe is represented by an ellipse. The Equator or the major axis is double of the central meridian or the prime meridian (*vide* the given figure). The meridians except the central meridian are curved lines and therefore the projection is not direction-true. The distances are not correctly shown as the side meridians are longer than the central one and those near it whereas actually they are all equal in length. The shapes are also distorted. It is, therefore, of use to show statistical and areal distribution, *e.g.*, population, crops, etc.

Summary of Important Projections[1]

Projection	Characteristics	Use
1. Mercator.	(*i*) Parallels and meridians straight: parallels equal in length to equator. (*ii*) Meridians spaced equally, but parallels spaced unequally. (*iii*) All bearings shown by straight lines. This is the best advantage. (*iv*) Conformal projection for points. (*v*) Areas greatly exaggerated. (*vi*) Pole shown by a straight line instead of a point. (*iv*) Cardinal points point the same way.	Sailing charts. World maps in atlases. Routes, direction of winds or ocean currents. Climatic maps generally. Also Hydrographic Map of the world. [illegible]
2. Mollweide's.	(*i*) Straight parallels, placed unequally. (*ii*) Elliptic meridians, except central and 90th. (*iii*) Equator divided truly. (*iv*) Distortion in shapes. (*v*) Equal area projection.	Distribution maps, especially world maps showing crops etc. [illegible]
3. Sinusoidal (Sanson-Flamsteed).	Same as Bonne's (See No. 5).	Best for areas near the equator (Africa or South America).
4. Simple conical (one standard parallel).	(*i*) Straight meridians. (*ii*) Concentric curves for parallels. (*iii*) Scale true only along the standard parallel. (*iv*) Neither equal area nor conformal.	For small areas in middle latitudes, like Denmark, Poland and Ireland.
5. Bonne's.	(*i*) Fixed straight central meridian. (*ii*) Parallels shown as equidistant concentric curves (*iii*) Curved meridians. (*iv*) Equal-area but not conformal. (*v*) Exaggeration on margins.	Survey maps in Holland and Belgium, etc. Good for any extent of longitude and therefore for transcontinental railways, etc.

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[1] Summarized from Dubey's 'Maps.'

Exercises

1. What do you understand by the term 'map-projection'? Name the chief types of Projections.

2. Are the following suitable? Give reasons for your answers.

(*a*) Mercator's for Canada and Greenland.

(*b*) Bonne's for Eurasia.

(*c*) Sinusoidal for Australia.

3. What projections will you use for a map of England, a map showing world distribution of wheat and for showing ocean currents?

CHAPTER V

SIMPLE SURVEYING

Prior to mapping, an area has to be very carefully surveyed for details. It is a very arduous task and requires a lot of practice and patience. The latest method is to survey from the air and take air photographs.

The most elementary methods of ground surveying are (1) Chain-tape survey, (2) Plane-Table survey, (8) Surveying with the Prismatic compass, and (4) Surveying with a Theodolite.

These different methods of surveying will now be described very briefly. Only very elementary details are given.

1. **Chain-tape survey.**—This is done with the help of a chain which is 100 feet long[1] and a tape which may be 100 or 50 feet long. This, method is used in the surveying of an area which is quite big and which cannot be measured with the foot rule or an iron yard. Chains are made of strong metals.

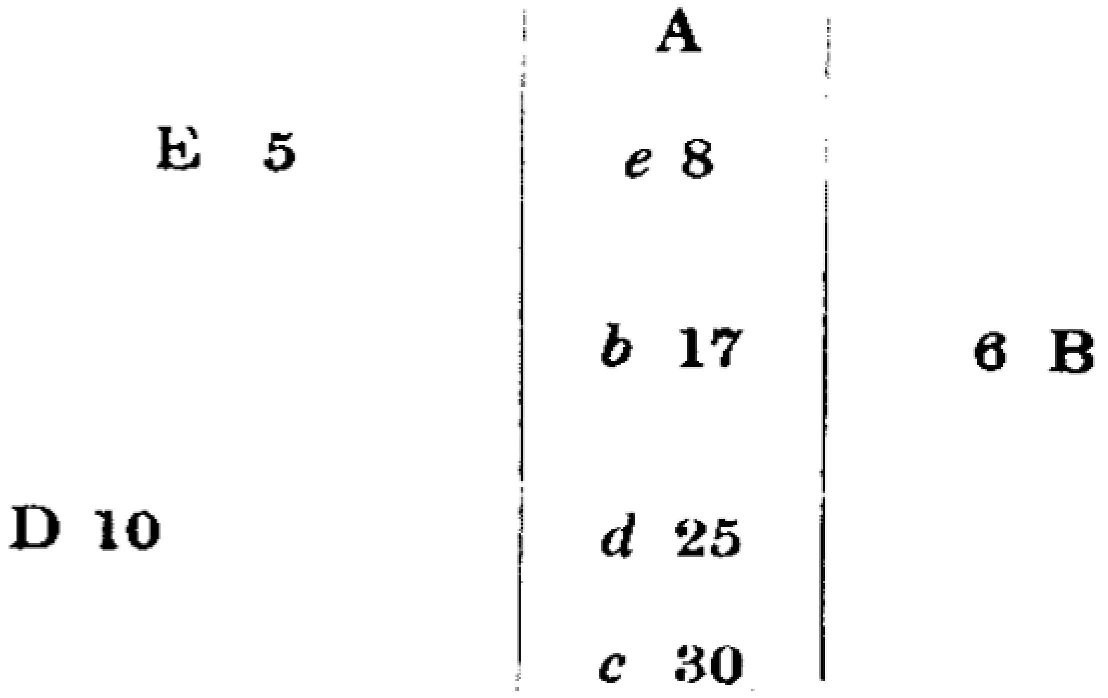

Fig. 15 Field Book.

It is very easy to survey with a chain. The figure shows an area to be surveyed. The points A,B,C,D,E, are the corners or points, which if joined freehand, give an approximate outline of the area in question. Before the actual surveying starts, a rough plan as indicated in the figure is made in the surveyer's handbook and the North-South line roughly marked. Then the two extreme points A and C are joined and their distance measured and put on the rough plan. Then using A C as the base prependiculars are thrown from the other points or corners (a perpendicular is

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[1] This is called '**Long Chain.**' The '**Short Chain**', also called '***Gunters Chain***' is 22 yards long.

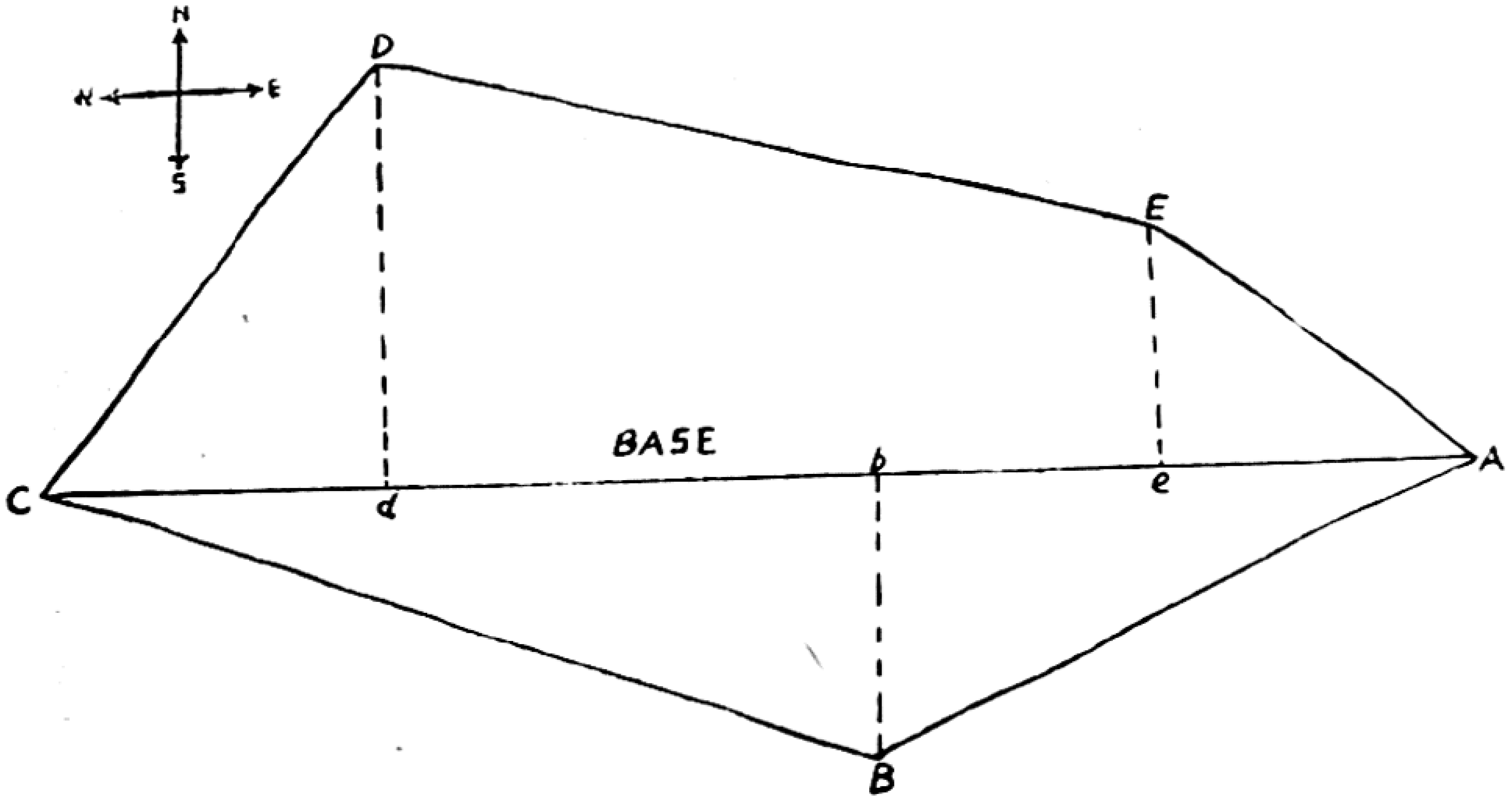

Fig. 16. Taking offsets.

the shortest distance between the point and the base) to it and their lengths measured. These 'secondary measurements' are called 'offsets.' For more accurate measurements an 'off-set finder' or a 'cross-head' has to be used. This method is however, used only for small areas having rather straight sides.

Another way for fixing the required points is by means

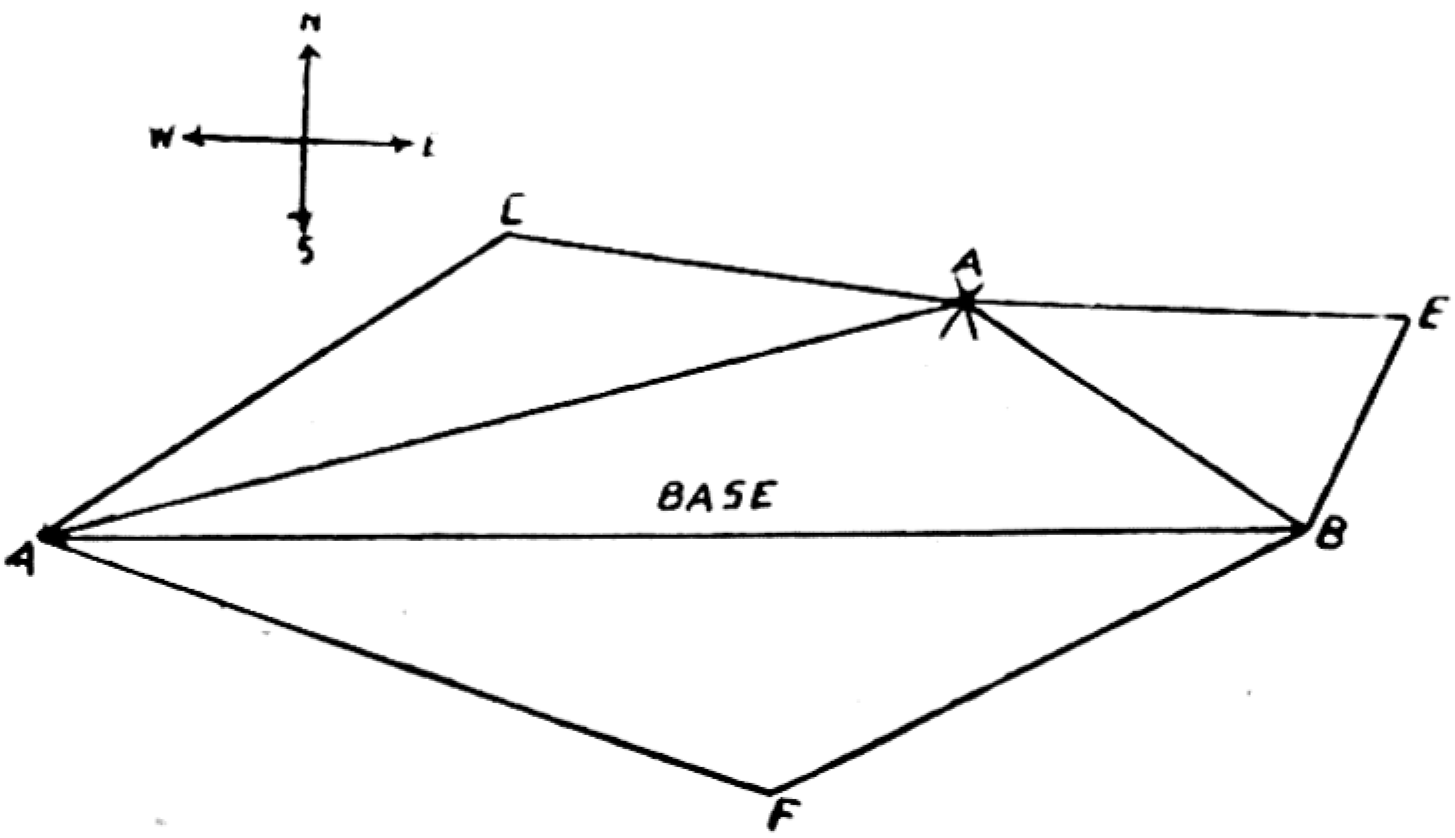

Fig. 17. By Triangles

of triangles. The figure 17 shows this method. The base

AB is measured. Then triangles are completed as given in the figure. To find out the position of point D sides AD and BD are measured. Now we now know the three sides of the triangle ABD. It is now easy to draw the triangle with AB as the base. Similarly all the other triangles and the required points are found out.

While drawing the figure. a suitable scale has to be used.

2. **Surveying with the plane-table.**—This method is very simple and even young pupils of 13 and 14 can use it. The figure shows what a plane-table with all its other equipment looks like. It consists of a Drawing Board mounted on a tripod stand and generally having a spirit level to see that the Board is flat when used. A ruler having a sight at each end is made to rotate round a pin thrust through a small hole at one end.

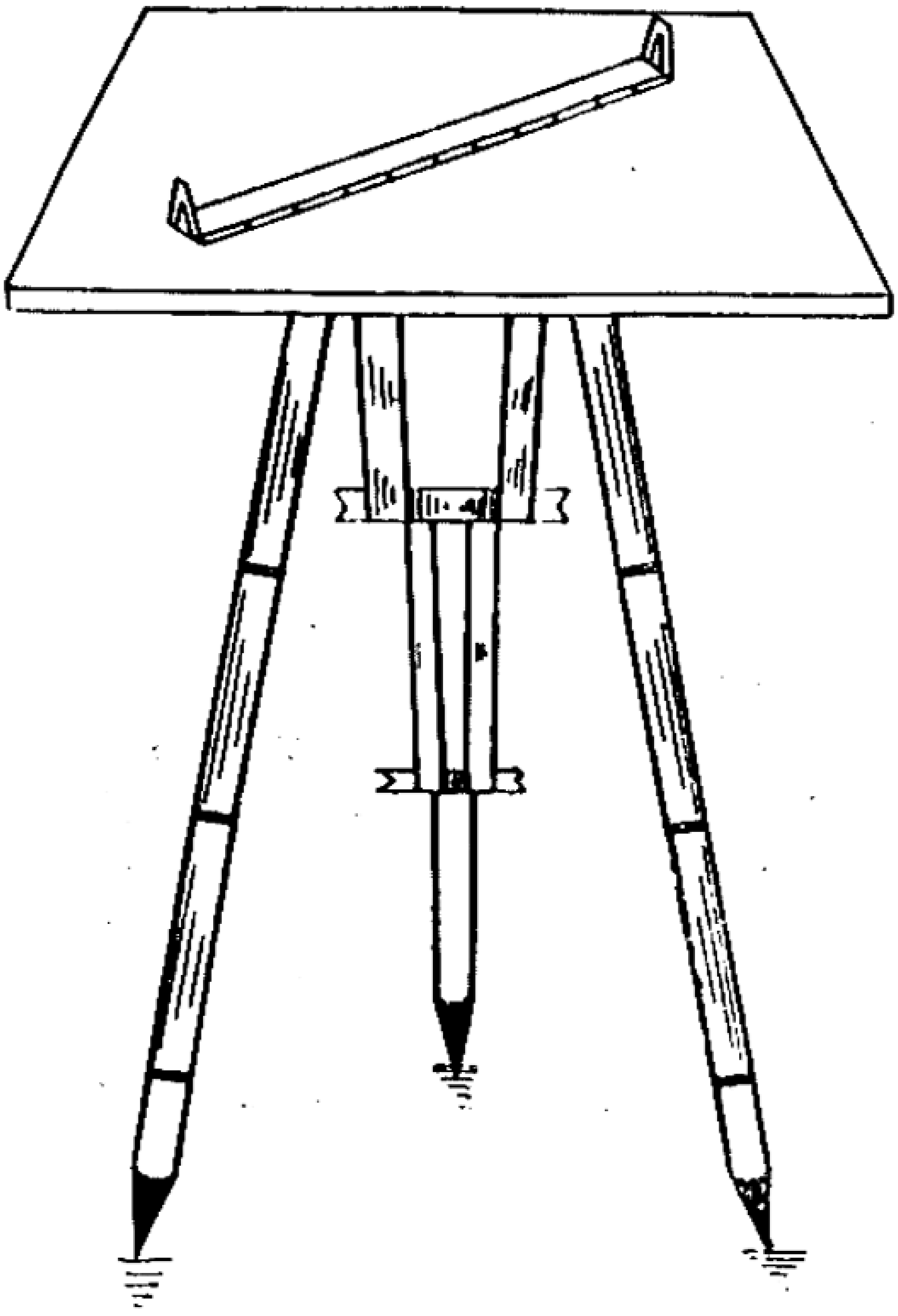

Fig. 18. A Plane Table

Put in very simple words the instrument is used thus. A suitable position 'A' is selected wherefrom the surveyer may be able to have a good view of the area concerned. The tripod is set up and the drawing board is screwed to it. It is essential that the board is made perfectly level. This can be easily done with the help of the spirit leveller. Then a fairly big piece of drawing paper is pinned to this board. Directions are then marked on this paper with the help of a compass.[1] A point is, then, marked on the paper to represent position A. Then a second point B is taken some distance away from A. From this point also all the area must be visible. The distance between A and B is measured and point B is also put on the paper (a scale has to be selected) and A and B are joined. Then with the help of the sight rule all the points to be observed are sighted first from A and then from B and rays drawn. Wherever the two lines sighting the same point intersect, that point is the position of the

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[1] **This is called setting or orienting.**

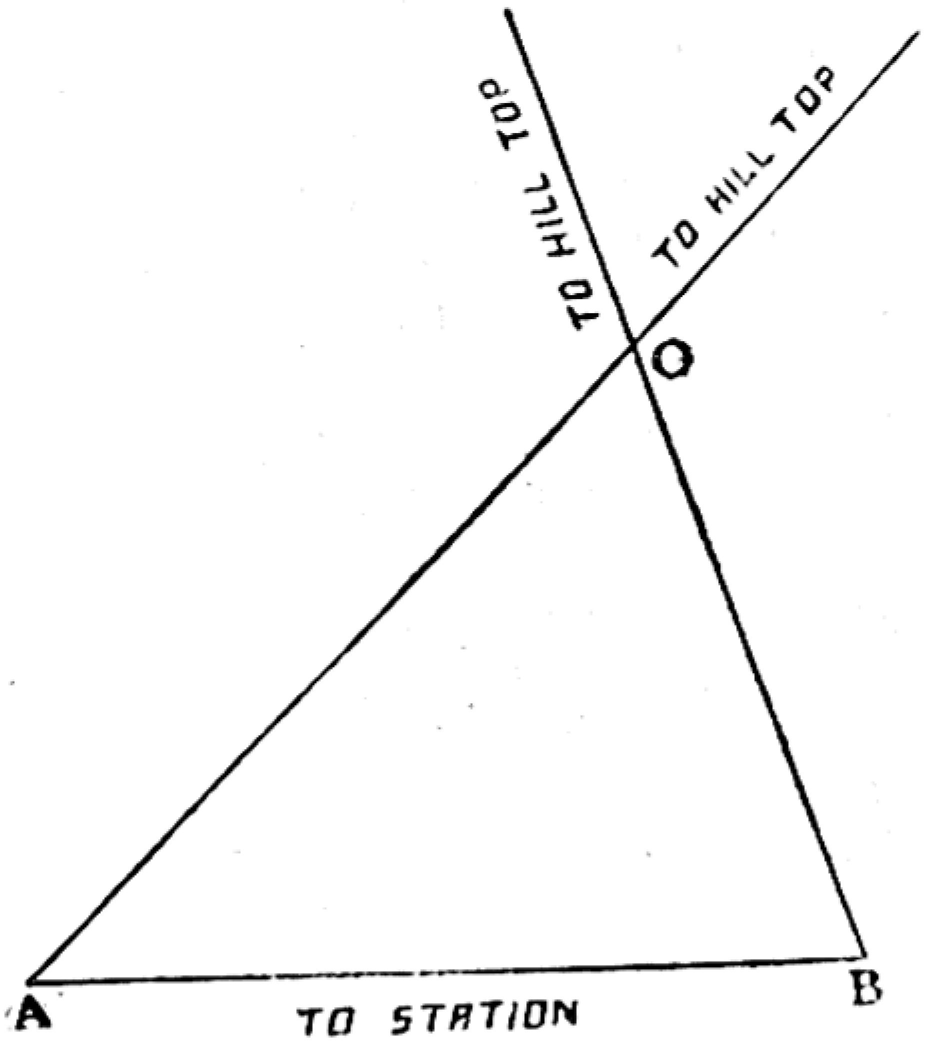


Fig. 19. Fixing a point. O is our point.

point in question (Fig 19). The points are then joined and our map is ready.

3. **Surveying with a Prismatic Compass.**—This instrument, as shown in the figure, is quite handy and is used

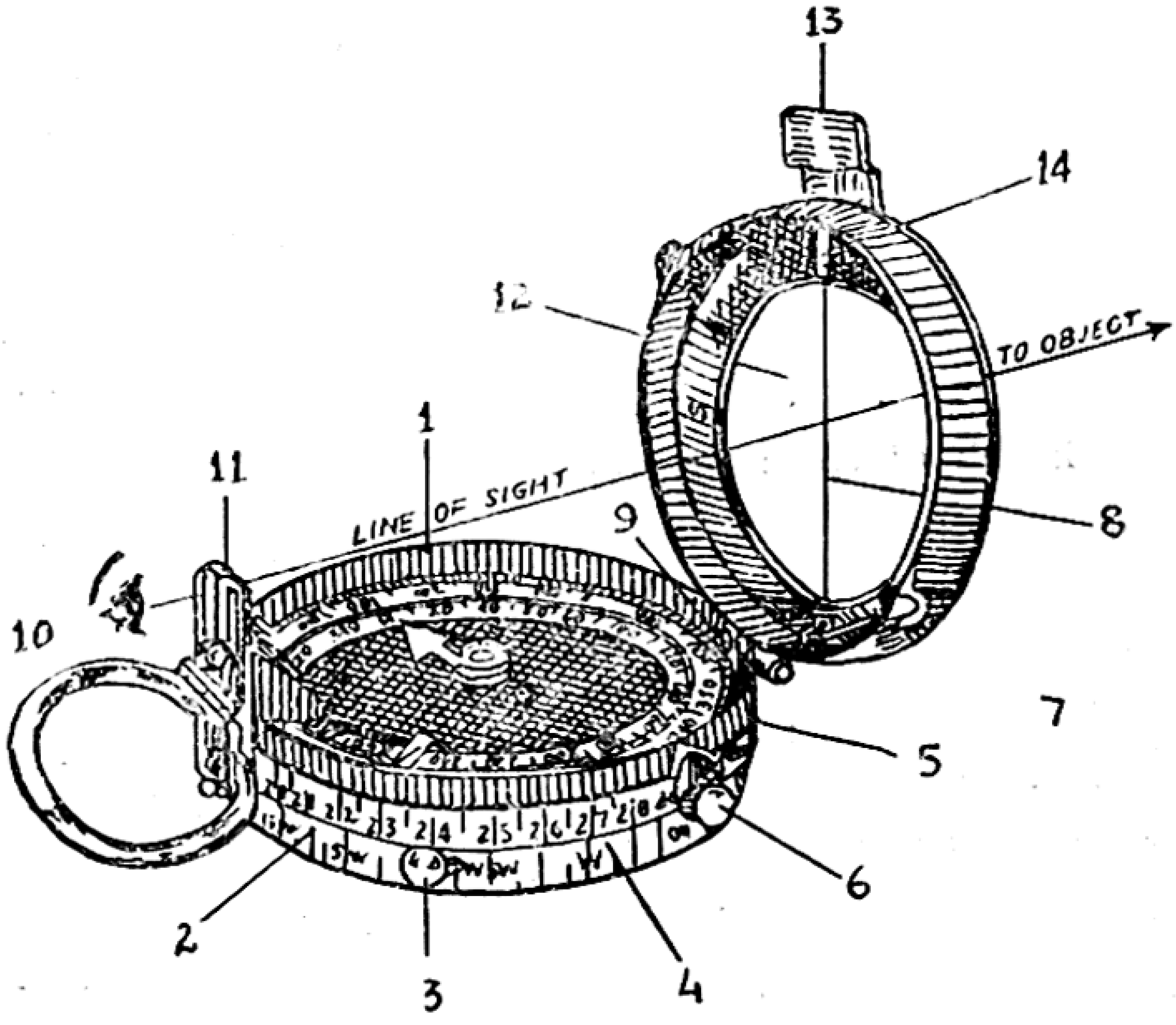


Fig. 20. A Prismatic Compass.

for a rapid survey of big areas. The instrument consists of an ordinary compass with two additions—a pair of sights for getting a distant object in line and secondly a prism to reflect to the eye the readings on the compass card immediately as the distant object is being sighted. The position of the object with regard to the magnetic North is then shown by the number of degrees East of North read off on the compass card. A distant object is got in line by means of the two sights. At the same time as you look at the object, the prism is reflecting into your eye the reading on the compass card.

Below is given a concrete example :—

	S 250 yds.	
	200 yds.	Boarding House 159°
Clock tower 20 yds.	150 yds.	
	50 yds.	Boarding House 100°
	T. 45°E	

The table above shows how you should write notes of your survey. You start from the point T and go towards a point S situated at an angle of 45° East of the Magnetic North.

Going 50 yards along the road you see a boarding house on the right-hand side and note the angle as 100° east of north. Going 150 yards more you come across a clock tower on the left-hand sids situated 20 yards away from the road (you need not measure the angles of objects which are situated within 100 yards of the road). After going a distance of 200 yards from T you sight again at the boarding house and find its angle to be 150° East of the North. Then you come to point S situated 250 yards from your starting point T, and at this point your course takes a turn and your further observations continue. In the given figure you see a sketch of the above.

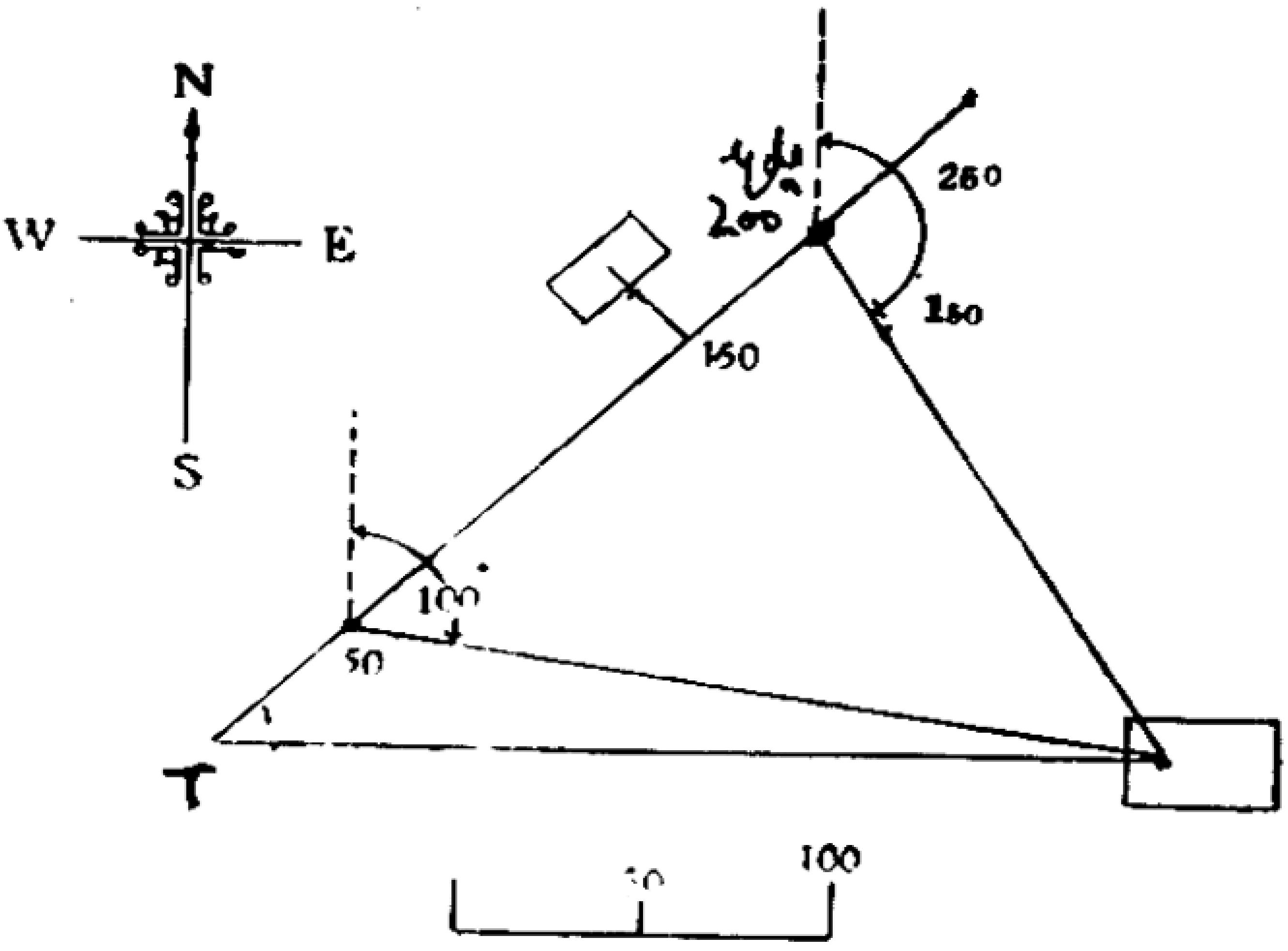


Fig. 21. Sketch of the area surveyed.

(4) A Theodolite Compromises of :

1. A horizontal circular plate furnished with two verniers 180° apart and graduated to read angles.
2. A vertical circle with two verniers graduates to read

from 0° to 90° in the first quadrant, and from 90° to 0° in the next quadrant.

3. A telescope which rotates about an axis passing vertically through the centre of the horizontal circle and capable of rotating adjustment so that it can similarly rotate about an axis passing horizontally through the centre of the vertical circle.

Bearings for the telescope and the vertical circle are carried on frames. Spirit levels are mounted on the horizontal plate and on the vernier arm of the vertical circle. The horizontal plate carries a compass in its centre between the supports of the telescope, and there is a screw to lift the magnetic needle off its pivot when not in use.

The theodolite is firmly screwed to a base or tripod, in the centre of which there is a Hook from which to suspend a plummet in order to indicate the exact position where the station peg is to be driven into the ground.

Sighting is done through a telescope, because the theodolite is designed for long distance work. In the telescope is a diaphragm, finely etched with a vertical and horizontal line, kept in place by screws. Accuracy is ensured by these lines, the intersection of which should coincide with the object. The telescope is brought into focus by a milled screw near the object glass. There is a screw to adjust the axis of the telescope.

The character of parts noted above varies in theodolites by different makers, and according to the price of the instrument.

The theodolite is used in triangulation, and for the determination of trigonometrical heights. As regards its function, it is a delicate combination of prismatic compass and a level, capable of very accurate readings. There is a considerable difference in the measurement of horizontal and vertical angles. On the horizontal circle the difference in bearing between one point and another is measured ; on the vertical circle the elevation of a point above the horizon is measured. Particularly in the latter case it is necessary to eliminate errors due to both instrument and observer. The principle of the use of the theodolite in triangulation can be seen if we imagine a triangle ABC representing an area in the district to be surveyed. The theodolite is set up at C, the telescope pointed on A and the reading of the pointer on the horizontal circle is noted. Still at C, it is next pointed on B and another reading taken. The difference between the two readings represents the angle ACB. The theodolite is then moved to B, and the angle CBA is ascertained. Finally it is moved to A and the angle BAC is similarly determined.

If the reading is accurate, the sum of the three angles should be 180°; but if this is not the case, various adjustments are made.

It is necessary to measure one of the sides of the triangle; and given this side and two of the angles determined by the theodolite, it is possible to calculate the remaining two sides of the triangle.

Determining Position by Resection.—By means of a method called '*Resection,*' the principles underlying plane-tabling can be used to determine one's position on a map. We set up the plane-table and line the sight-rule on certain selected distant objects. Rays are drawn backwards from these objects to the observer, whose position is indicated by the intersection of the rays.

Select three objects in the country which you can identify on the map. Set up the plane-table, orient it, and fix the map on the table. Draw rays from objects in the country through their counterparts on the map and towards yourself. If these rays intersect at a point, this is your position. In practice it is possible that they will not intersect, but will form a triangle known as the "triangle of error." This error may be due to faulty setting of the plane-table or to defects in the compass.

The three objects should be so selected that they and you are not be on the circumference of a circle. It is advisable, if possible, to select objects so that you are within a triangle formed by imaginary lines joining the objects.

If you can select the objects so that you are inside such a triangle, you are inside the triangle of error. If you cannot so select them, you are outside the triangle of error.

Your position can be estimated approximately. If you are inside the triangle of error, the distance of such position perpendicularly from any ray is proportionate to its distance from the object from which the ray was drawn. If you are outside the triangle of error, your position is either to the right or the left of all the rays as you look towards the three objects in the actual country.

To test whether you are to the right or to the left of the rays, slightly turn the table-top, say, to the left, and draw new rays from the three objects. If the triangle of error resulting from the new rays is smaller than the first triangle of error, your position is on the left of the rays. If the new triangle is larger than the first one, you are on the right of the rays. The rays make six sectors, but your position can only be in one or two, 3 or 6, *i.e.* either to the right or left of the rays. Having determined as directed above whether you are to the left or to the right of the rays, it will be at either X or Y. Lines drawn from X or Y at right angles to the rays are in proportion to the distance from X or Y to the objects from which the rays are drawn.

Resection by means of a Tracing Paper :—Fix a piece of tracing paper on the plane-table and levelling the latter select three objects in the country which can be identified on the map. Put a dot on the tracing paper to represent your position. From the dot sight those three stations by turn and draw rays. Unpin the tracing paper and pin the map on the board. Place the tracing paper on the map, move it either ways until each ray passes through the object on the map corresponding to the real object from which the ray was originally drawn. Pin the tracing paper on the map in this position and prick through the dot, *i.e.* through the point of intersection of the rays. Your position will be indicated by the prick thus made on the map.

Theodolite-Survey

(*a*) Centre up the theodolite carefully over the station where the angles are to be measured.

(*b*) Level up carefully with the levelling screws.

(*c*) Set a screw of the verniers on the zero on the scale.

(*d*) Unclamp the bottom plate, aim the telescope moving the eye piece in or out.

Bring the intersection of the hair to the point where signal enters the ground, or any other lowest possible point, clamp the bottom plate and read the vernier. This is the angle through which the telescope has moved before measuring the required angles. This angle will, therefore, have to be substracted from the readings got from measuring the first angle. Sometimes a start is made when the vernier reads zero degree when the first point is observed. Unclamp the upper plate and turn the telescope to look at the second station. The vernier should then be read. It will give the whole angle. When the telescope is twisted by substracting the initial angle we shall get the required angle. The readings may be entered in a table like this :—

Station	Point	Vernier (*a*) all	Vernier (*b*) only for minutes	Mean	Difference	Name of angle
x	B	42 48	42	42 45	3	AXB
x	C	84	—	84	—	AXC
x	D	130 24	20	22	2	AXD
x	Y	166 50	47	48 30.	5	AXY

Measure the lengths of the objects from the point.

Now by reducing the lengths to a definite scale, and having got the angles, draw the sketch.

This kind of survey can only be done in places where the country is level and the objects are clearly visible.

CHAPTER VI

MEASUREMENT AND REPRESENTATION OF HEIGHTS

SECTION A

(MEASUREMENT)

Measurement of heights is an important part of practical Geography. It is easy to measure the height of small objects like a tower or a tree by means of a tape if one can easily get to the top but for higher things more scientific methods must be followed.

1. **By means of shadows.**—Towards noon on a bright day, stick a pole in the open and measure its shadow and then find out its proportion to the actual length of the pole. Apply this to shadows of objects whose shadows can be measured, and you can find out their heights. Suppose the shadow of the pole is half of the height of the pole, then the heights of all the objects will be double the lengths of their shadows at that time. It is best to measure the shadows near about midday because then the shadows are more or less equal to the heights of the objects.

2. **By means of a Theodolite.**—(*a*) Take some point in front of the object of which the height is to be found, on some level ground from which the length between the object and the point can be easily measured.

(*b*) Put the theodolite on the point and level it.

(*c*) Put the upper Vernier at zero.

(*d*) Set the telescopic verniers at zero.

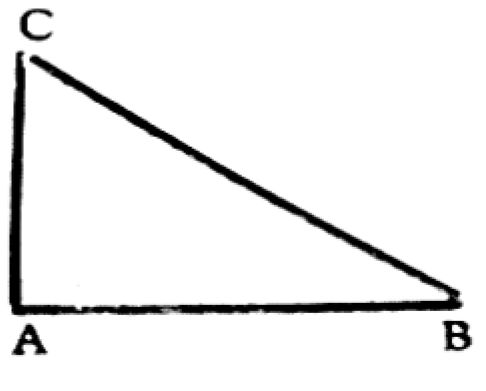
(*e*) Aim at the trunk of the object through the telescope.

(*f*) Measure the base.

(*g*) Raise the telescope till you sight the uppermost part of the object.

(*h*) Read this angle from the telescopic Vernier; and apply the following formula and you shall get the height of the object.

Height = base × tan. of the angle found.[1]



[1] **Consider a right-angled triangle ABC. The ratio of height, *i.e.* AC to the base, *i.e.* AB is called the tangent of the ∠ABC.**

$$\text{Tan ABC} = \frac{AC}{AB}.$$

If the ∠ABC is known, tan ABC can be read from Mathematical Tables.

3. **By means of a clinometer.**—Clinometer is a popular instrument for measuring heights. Select a point fairly away from the object, measure its distance from the front of the object (Base). First level your clinometer with the base line and then tilt it till your eye and the clinometer face the top of the object, read this angle. Construct this right angled triangle to a scale (the object stands at 90° to the Base) and by measurement and calculation you can find out the height of the object.

A well-known type of clinometer is the *Abney level.* This is essentially a telescope, to which is firmly fixed a protractor. This is read by a vernier, carried on an arm, pivoted at the centre of the protractor. A spirit level, is fixed rigidly so that it is at right angles to the arm, which carries a milled knob, enabling the level to be moved. The spirit level is parallel to the line of sight. Under the centre of the level there is a window cut in the telescope, and inside the telescope there is a small plane mirror at an angle of 45° to the line of sight of the telescope. When the observer uses the instrument to find an angle of depression or elevation, he looks through the telescope at the object, which should appear on the crosswire of the diaphragm. He then turns the knob carrying the spirit level until he sees the bubble of the level reflected in the mirror on the telescope crosswire. The spirit level in horizontal, and the required angle is read.

When the angle of elevation has been read the height can be found thus :—

Height = tan. of angle × base.

The Indian clinometer is amongst the best height measuring instruments.

4. **By means of a Barometer.**[1]—A Barometer measures the pressure of the air. The pressure of the air decreases as we go high up in the air. The rate of decrease being 1/10 of an inch for every 90 ft. of ascent. The only thing we have to do is to mark the pressure of the air at the bottom of the hill and then to mark it again when we reach the top. Finding the height of the hill now remains a matter of mere calculation.

Depths could be found out in the same way.

The *Aneroid Barometer*[2] is graduated to show a scale of feet to considerable heights, such as 15,000 or 20,000 feet.

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[1] Used only when we can reach the top of the object.

[2] An Aneroid Barometer may be seen in any Geography room.

The principle of the instrument for reading heights is that the reading of the barometer varies with altitude, because the density of the air so varies and consequently pressure on the "drum" varies. It is necessary to observe corrections for temperature of the barometer and of the surrounding air. Such corrections are given in prepared tables. The reliability of the barometer varies with different weather conditions. A rough check is possible by using two instruments, the Hypsometric Aneroid and the Open Range Aneroid, and taking a mean of their readings.

In using the barometer to fix the approximate position of contours, the observor should work between points of known heights. If the student knows the height of stations in a valley, say 568 feet, and on a hill-top, say 1,020 feet, the barometer would be first set to the known height at the valley station. The observer would then move along some convenient salient, halting when the barometer readings differ from the known heights of the hill stations; there should be proportionate correction of all the contours. Barometer heights are useful where it is not possible to fix a trignometrical station, as in forests and deep valleys observed from a height.

A *Sextant* is used to measure both vertical and horizontal angles. The height of the sun is also measured by it.

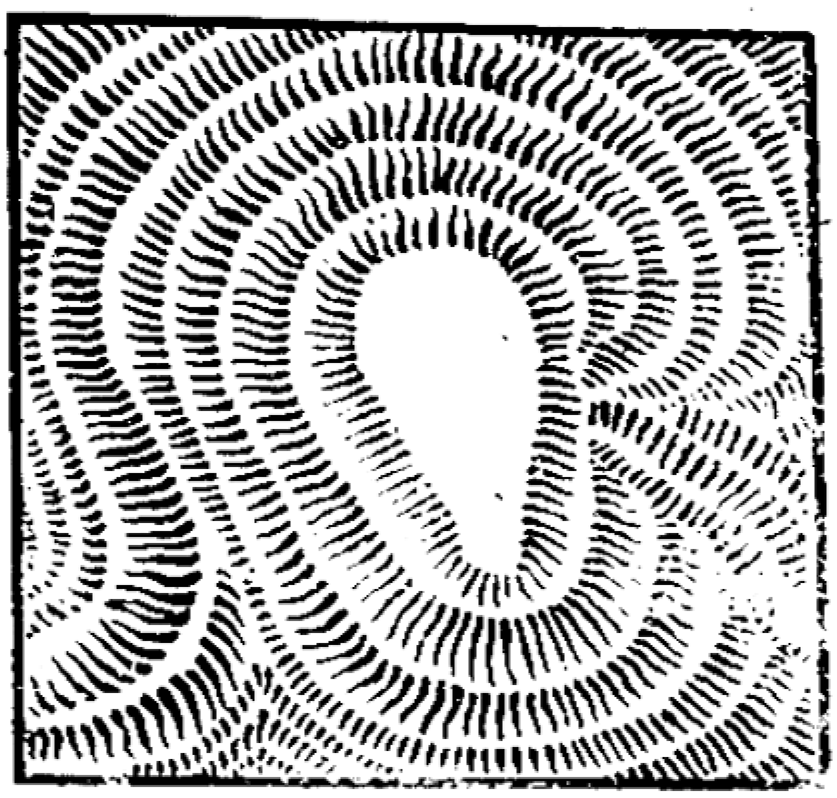
SECTION B

(REPRESENTATION)

(*a*) **Contours.**—A *Contour* is a representation on a map of an imaginary line joining all adjacent points which are of the same height above the sea level. Contours are drawn at a given *vertical interval* from one another. Walking along a contour line means neither ascending nor descending. They show relative heights and represent all sorts of topography. They however fail on very abrupt slopes, broken slopes, broken cliffs and very flat lands.

Prior to drawing contour lines a number of heights (Spot Heights) are plotted. Prominent ones are enclosed in a triangle and are known as *Trignometrical Stations*. The interval between contour lines is called Vertical Interval (V.I.). Close contour lines depict steep slopes and wide contours show gentle slopes. They are usually drawn at an interval of 100 feet or more to avoid overcrowding of maps.

(*b*) **Form Lines :**—On small scale maps heights are sometimes represented by Form Lines. They may be defined as contours (1) not usually figured, and (2) broken. They show the general form of the land, but not the actual heights. They are used as supplementary to contours specially at the top of a hill. *Peaks and summits are clearly marked.*



Hachuring
Fig. 22.

(*c*) **Hachures** indicate the direction, water would take if it flows freely. They are short disconnected lines drawn towards the slope or in the direction of the steepest gradient. When the slope is steep they are made short and close together, when the slope is gentle they are lighter and farther apart. The flat ground is not shaded.

They convey at a glance a general idea of the relative steepness. In a contoured map, when the vertical interval is large the addition of hachures is useful in showing minor features which are generally not shown. The main drawback is that they interfere with other details and reduce the legibility of the lettering of the map. They do not show relative heights, and, therefore, spot heights are necessary to differentiate between a valley and a hill. They are more usually done in colour.

(*d*) **Layers or Hypsometrical tints**.—Layers or tints of colour are used to show all land between two known contours. Blue is used for water bodies ; green for plains ; brown for highlands ; and white for glaciated regions. Different shades of the above colours are used to show comparative studies. This method is becoming more popular, because a clear picture of high and low land can be had at a glance. There is however no exactness because the colours change very abruptly.

(*e*) **Bench Marks** are placed on buildings, walls, etc., showing their height as determined in levelling operations. They consist of an arrow pointing to a horizontal line.

(*f*) **Trignometrical Stations** are sometimes shown with their heights. They are points on the earth's surface where angles of a triangulation are measured. *Ariangulation* is a method which divides a country into triangles for the purposes of survey.

(*g*) **Hill Shading** gives the general idea of the relief of a country, and is suitable for small scale maps. The hillsides and mountain sides are shaded dark; while relatively flat land, such as valley bottoms, plateaus, etc., are shaded in a lighter tint. The shading is really 'stippling', comprising of very small dots. Hill shading does not show absolute heights and gives merely an idea of relief. Uphill and downhill is difficult to determine.

Hill shading gives the appearance of a model. This method of showing relief is used in the French 1/50,000 maps. Hill shading is designed so as to appear as shadows resulting on the slopes which face south and east, as though the Sun was shining from the north-west.

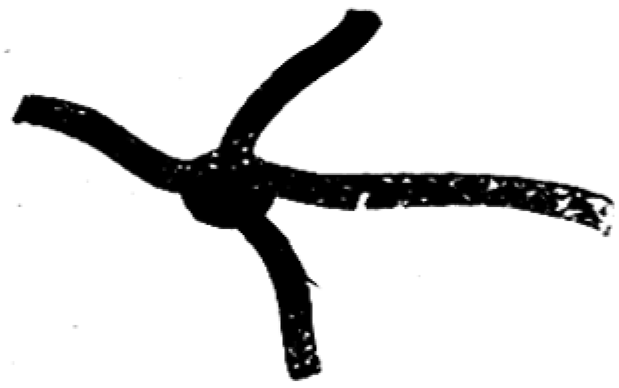


Fig. 28.

(*h*) The figure shows a very elementary method of showing highlands. This is useful for very young people and is not at all satisfactory as it in no way, conveys any idea of varying altitudes, of gradients or of an area.

Showing relief by means of Contours

A contour line is a line joining points of equal heights above the sea level. On a map it appears as a continuous line. If we walk on a contour line, it shall mean neither ascending nor descending. In the case of hills and mountains contour lines take circular shapes and appear as rough concentric circles. When we go to hills by car, the road goes round and round the hills, ascending gradually; this is done because a car cannot ascend an abrupt slope. Take a concrete example—one contour line is marked 100 feet and the other 200 feet.[1] This means that the land on the two lines is 100 and 200 feet high respectively; the land in between these two lines varies in height from 100 to 200 feet above the sea level. In case of steep slopes, the contour lines are closer together. If the lines are farther away, it shows that the slope is gentle. Peaks are shown as small triangles with actual height figures.

Section Drawing.—A section represents the surface that would be exposed if the ground were cut through in a particular direction in a vertical plane. Or to put it in simpler words, a section shows how a relief feature will appear if viewed from flat land some distance away. Fig. 24 shows the section of a hill. It is, useful to learn how a section is drawn from a contour map. AB is a straight line drawn through the contour map, cutting the various contour lines at C, D, E, F, G, H and I. Before we draw this line we should decide a line of profile. Parallel to AB another line of equal length is drawn some distance away. Then vertical lines are drawn from the points of intersection of AB with various contours, on the second line. Then a scale of heights is drawn as shown in the figure. The various heights are then plotted and the profile completed.

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[1] The figures are shown on that side of the contour line, which faces rising ground. They are given in a straight line.

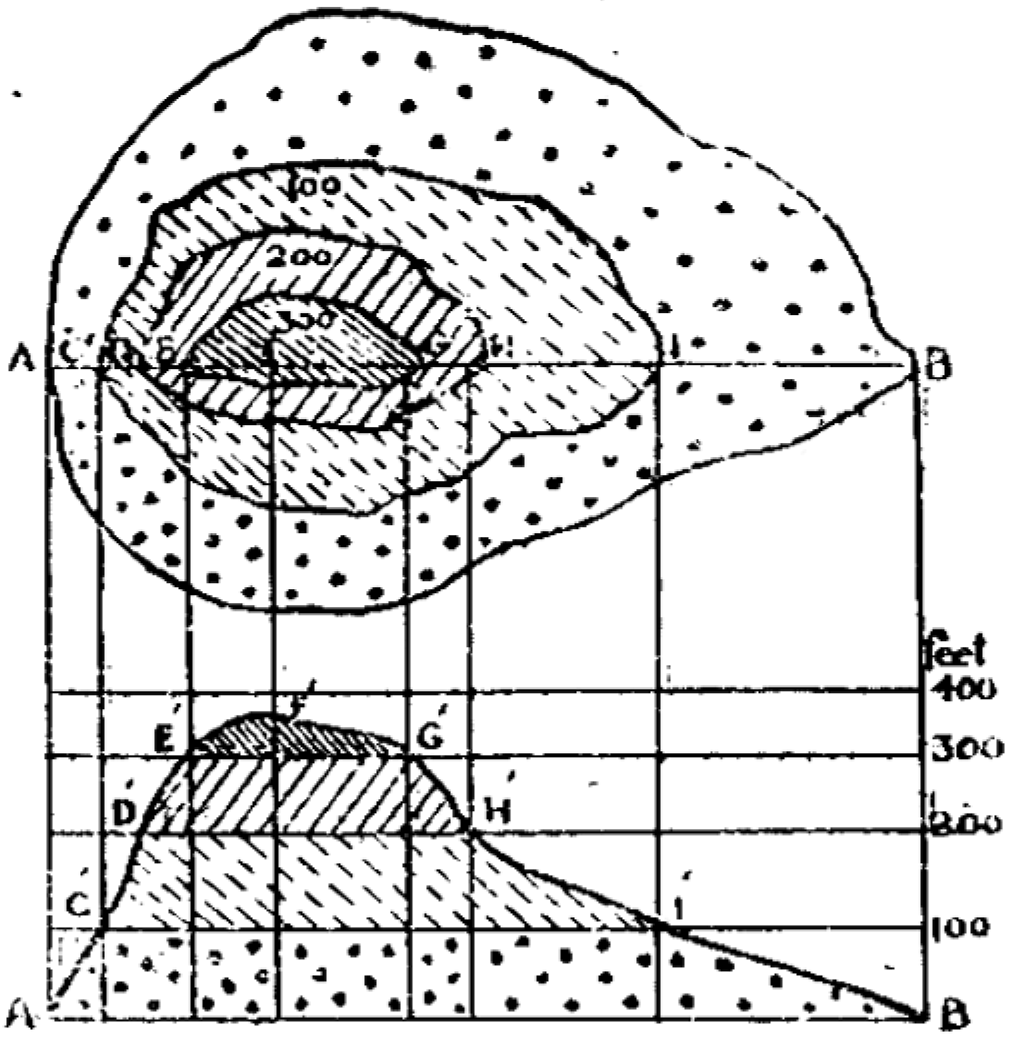

Fig. 24

If it is desired to draw the section on a separate piece of paper, a different method may be followed. Draw a line equal in length to AB. Draw perpendiculars at A and B and on them construct the scale as required. Then put the points C, D, E, F, G, H, & I at corresponding distances; plot the points and complete the profile.

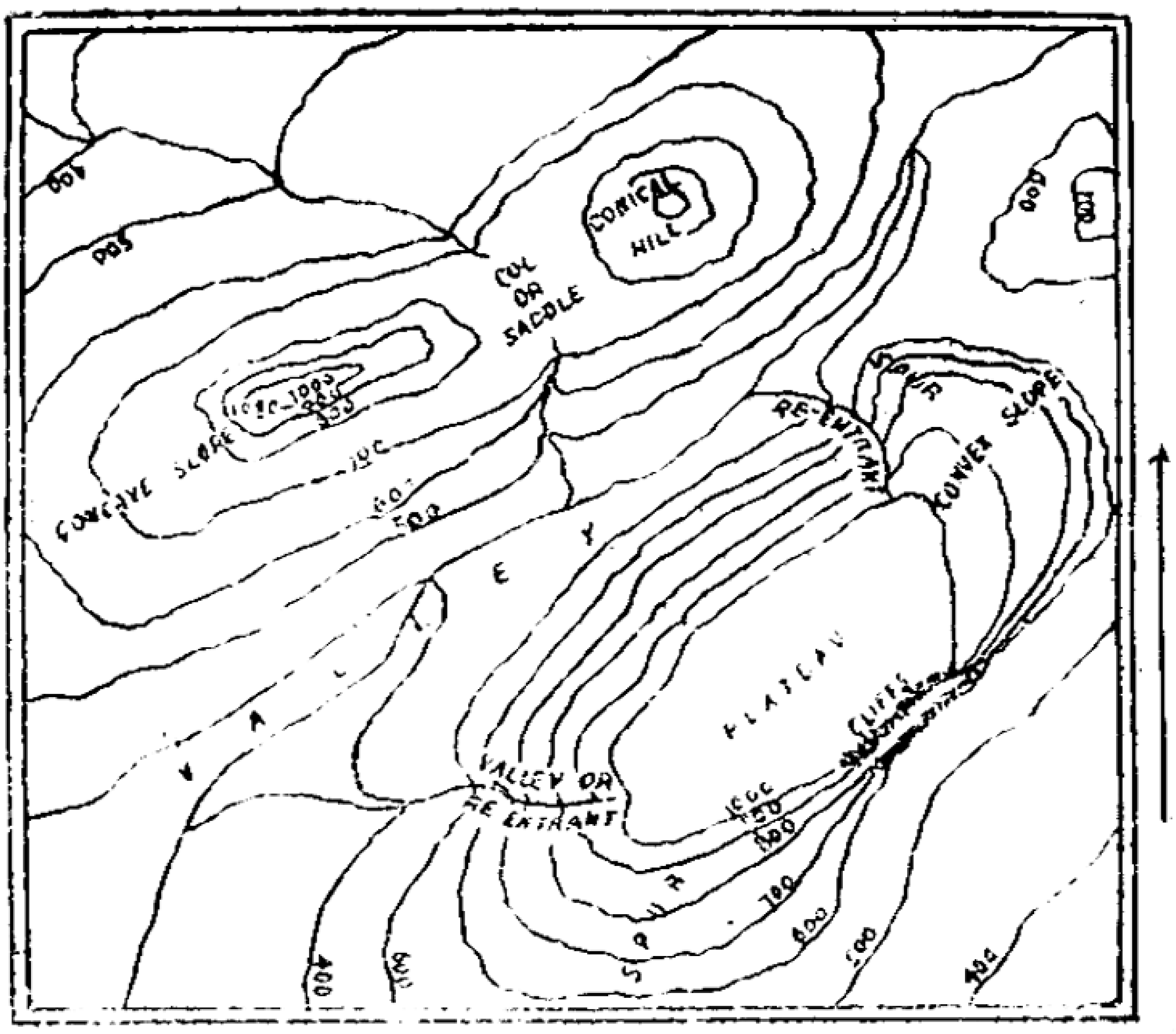

Fig. 25. A consolidated contour map.

We can draw a large number of sections of the same relief feature from different sides and angles. When the line of section runs across the feature, the section is called a *cross-section* ; when it runs the length of the feature, it is called a *longitudinal-section.*

Different Contour Shapes :—Contours assume different shapes for different relief features and it may be useful to learn these different contour shapes.

Fig. 25 shows a consolidated contoured map of an area having most of the relief features ; and it will be better for the student to study it very carefully and note the various shapes.

Slopes.—Slopes are either steep or gentle. But this is a very vague and elementary classification and something more accurate and scientific may be known. Four types of slopes are recognised :—

(*a*) When the contours are evenly spaced but the degree of steepness is the same throughout the slope, it is said to be an '*uniform slope.*'

(*b*) In *convex slopes* the vertical interval is small towards the lower ground and increases as we go higher up.

(*c*) In *concave slopes* just the opposite is the case, *i. e.*, the space between contours is greater towards the lower ground and it gets less higher up.

(*d*) *Undulating slopes* have a series or a combination of the above types.

The question of visibility is closely allied to the above and is important from the military point of view. Visibility is good on uniform slopes. One could view both up and down the slope.

Visibility is better and one can see from the highest ground to the lowest ground and *vice versa* on a concave slope, while it is just the opposite on a covex slope.

If the map shows that there is some high ground between two points, then vertically they cannot be viewed mutually. If low ground lies in between, then they are mutually visible.

Valleys.—Figs. 26 shows valley contours. In the case of a river valley, the contours look back in a V-shape towards the higher ground. A water course usually runs along a line where two converging slopes unite. The source of the river lies, as is obvious, on higher ground. Fig. 26 B shows a valley with steep sides.

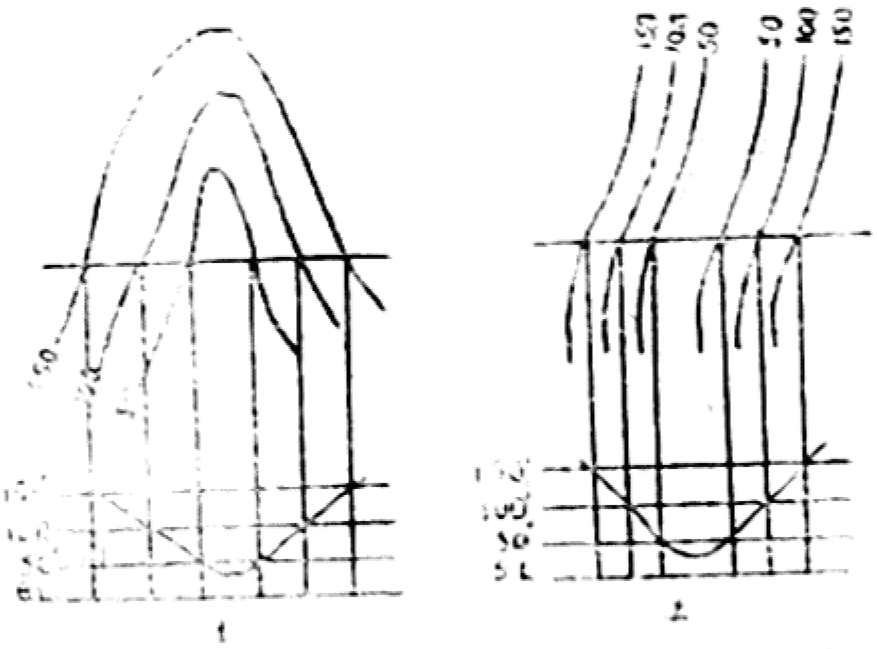

Fig. 26. - A. River valley. B. Valley·

A Conical Hill (or a Knoll)—This is shown by more or less concentric circles—evenly spaced, the ground gradually rising towards the centre.

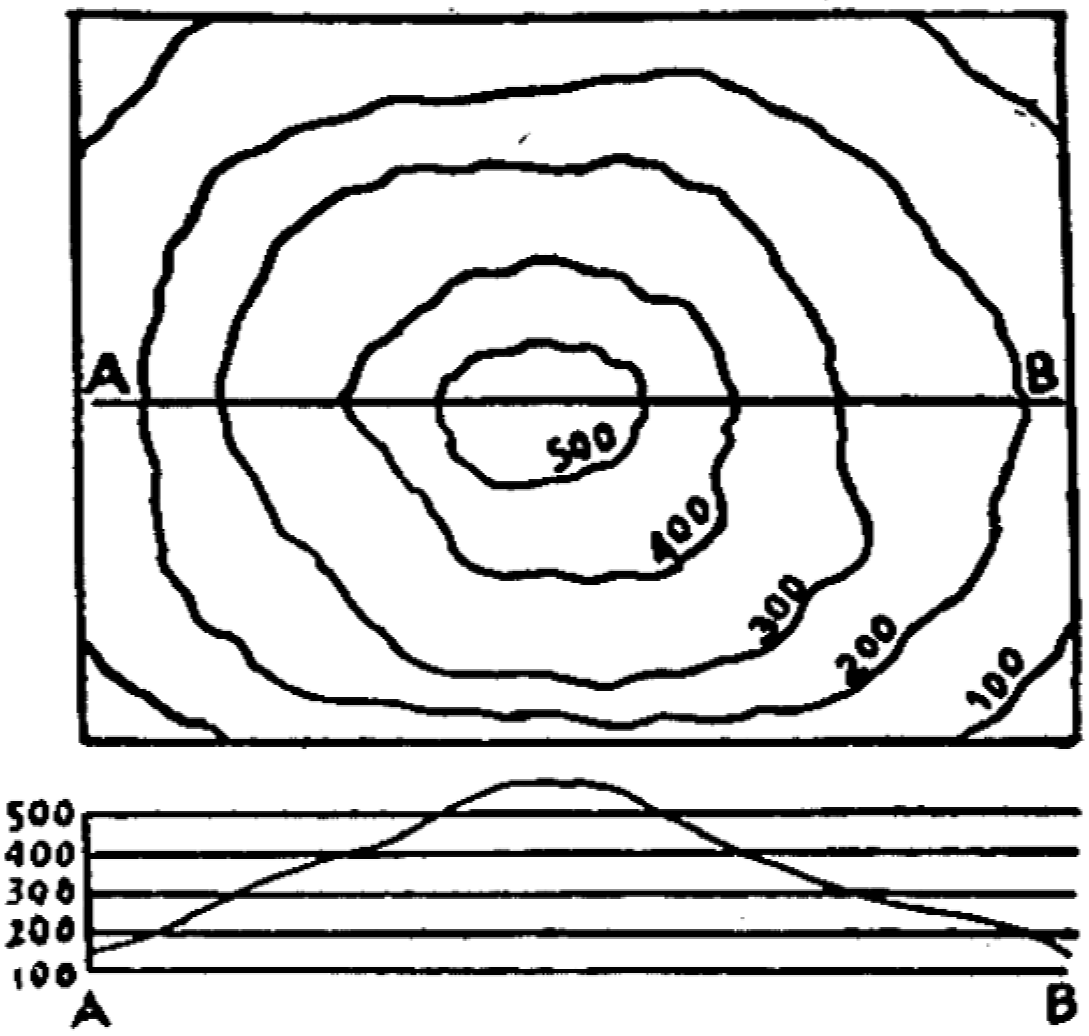

Fig. 27. A Conical Hill

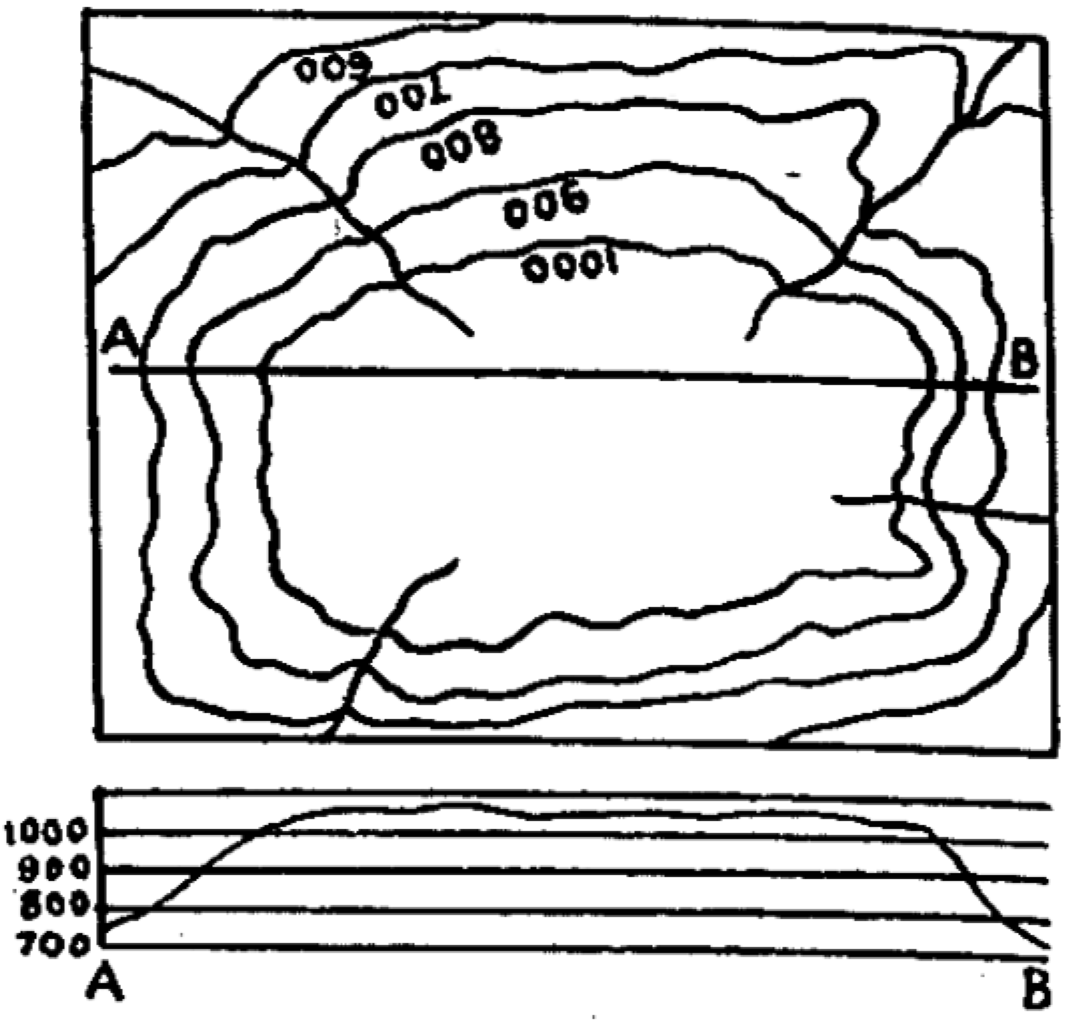

Fig. 28. A Plateau

A Plateau is broad flat land lying at some height. There are no contours on the highest points which are flat like a plain. But the land falls abruptly along the margins. The sides of a plateau are usually steep and naturally the relevant contours are close together.

A Spur (an offshoot or a salient) is a piece of high ground jutting out from a hill or a mountain into the surrounding lowlands. The contours are usually V-shaped but the apex of the V-points towards the lower land (fig. 29). Care may be taken not to confuse spurs with valleys.

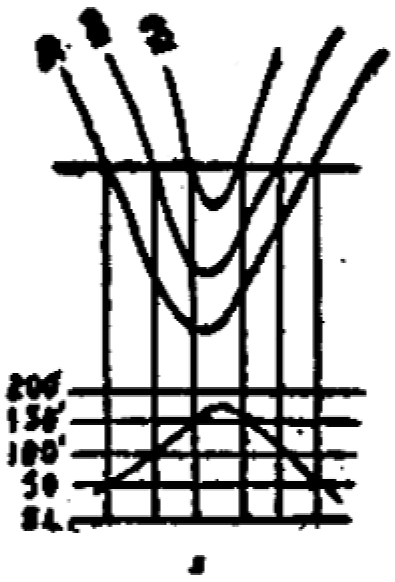

Fig 29. Spur.

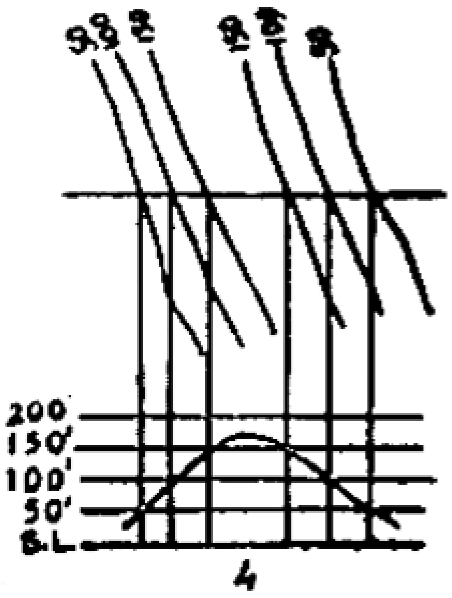

Fig. 30. Ridge.

A Ridge is an elongated hill. Study the shape of the relevant contours in figure No. 30.

A Cliff or a steep rock face is shown by contours very closely situated and often cutting one another. Cliffs may also be shown by the conventional signs used for the purpose.

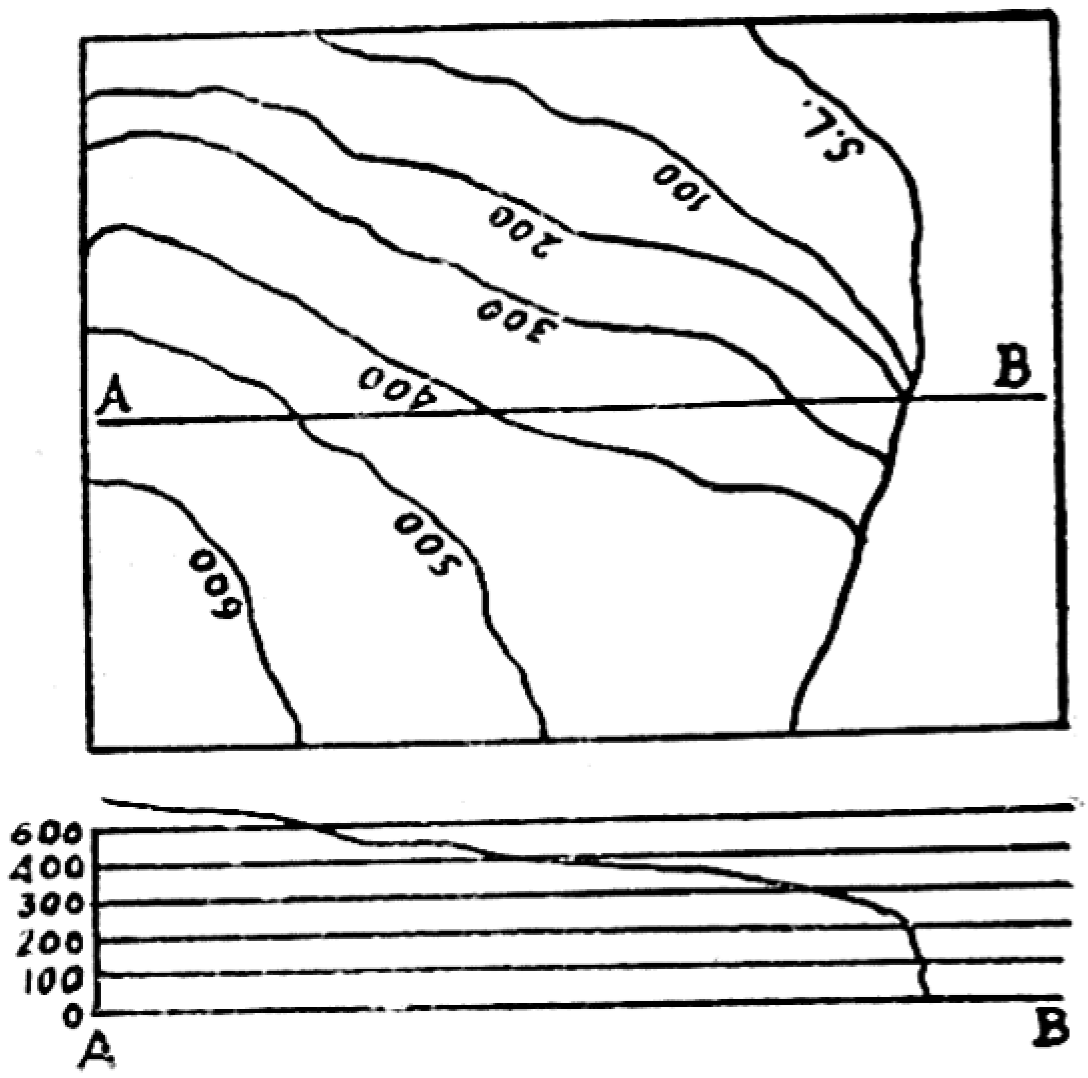

Fig. 31. A Cliff.

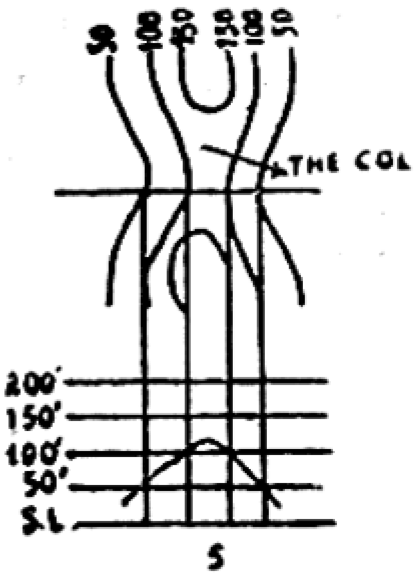

Fig. 32. Col.

A Col (or saddle) is the low land that connects two hills or mountain peaks. Because of its low elevation, it is used to cross hills or mountains—a *pass*.

The steep sloping side of a ridge is called an *escarpment* or a *scarp*. It may be similar to a cliff in character. The gentler slope that may back it, is called the *Dip slope*. (Fig. 33).

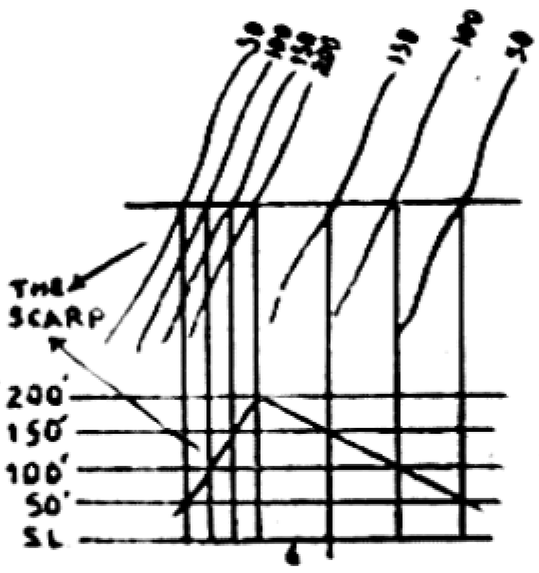

Fig 33. Scarp

Points to remember.—While drawing or reading a contour map the following points must be remembered.

1. While measuring distances, it should be remembered that on account of the sloping nature of the land, the actual distances are greater than those measured on the map. But usually the error is not great, about 2 per cent for a rise of 1 in 5.

2. While drawing railway lines or roads, it must be remembered that they cannot directly ascend steep gradients. Large hills are usually avoided or tunnels made through them.

3. Rivers and watercourses keep to the valleys, joining the angles of the Vs.

CHAPTER VII

MAP READING

Reading of a map means to describe in spoken or written words the natural and human conditions found in a certain area. The amount of details that can be shown in a map depends on its scale. For instance greater details can be shown on maps drawn on a scale of 1" to a mile than those drawn on 1/M or 1" to 16 miles. The next point to be acquainted with is the list of conventional signs. These are simply symbols used to denote a relief feature or any other material shown *e.g.*, roads, railways, canals, clock-towers, etc. The conventional signs differ from country to country. They also differ for different categories of maps. The size of symbols may also vary according to the scale of the map. The survey of India issue a big sheet giving full details about the conventional signs used in the various survey sheets issued by the department. Some of the more important symbols have been produced here ; the scheme followed being the same as given by Prof. Dudley Stamp in his small book " India and World Studies." This sheet is usually kept by all colleges and the students would do well to study that in addition to the details given here. " By the exercise of a little patiences, but much practice, the reader may soon become acqueinted with the main signs used." Usually most of the signs used in a certain map are given in the margin of that particular survey sheet.

A map may be quite successfully read on the following lines :—

1. **General Geography**.

(*a*) The No. of the sheet and the area shown therein.

(*b*) Scale of the map.

(*c*) Position of the area. It may be marked by means of well-known places and physical features or rivers, etc. North Point.

(*d*) *Relief of land.*—(1) A study of the contours,

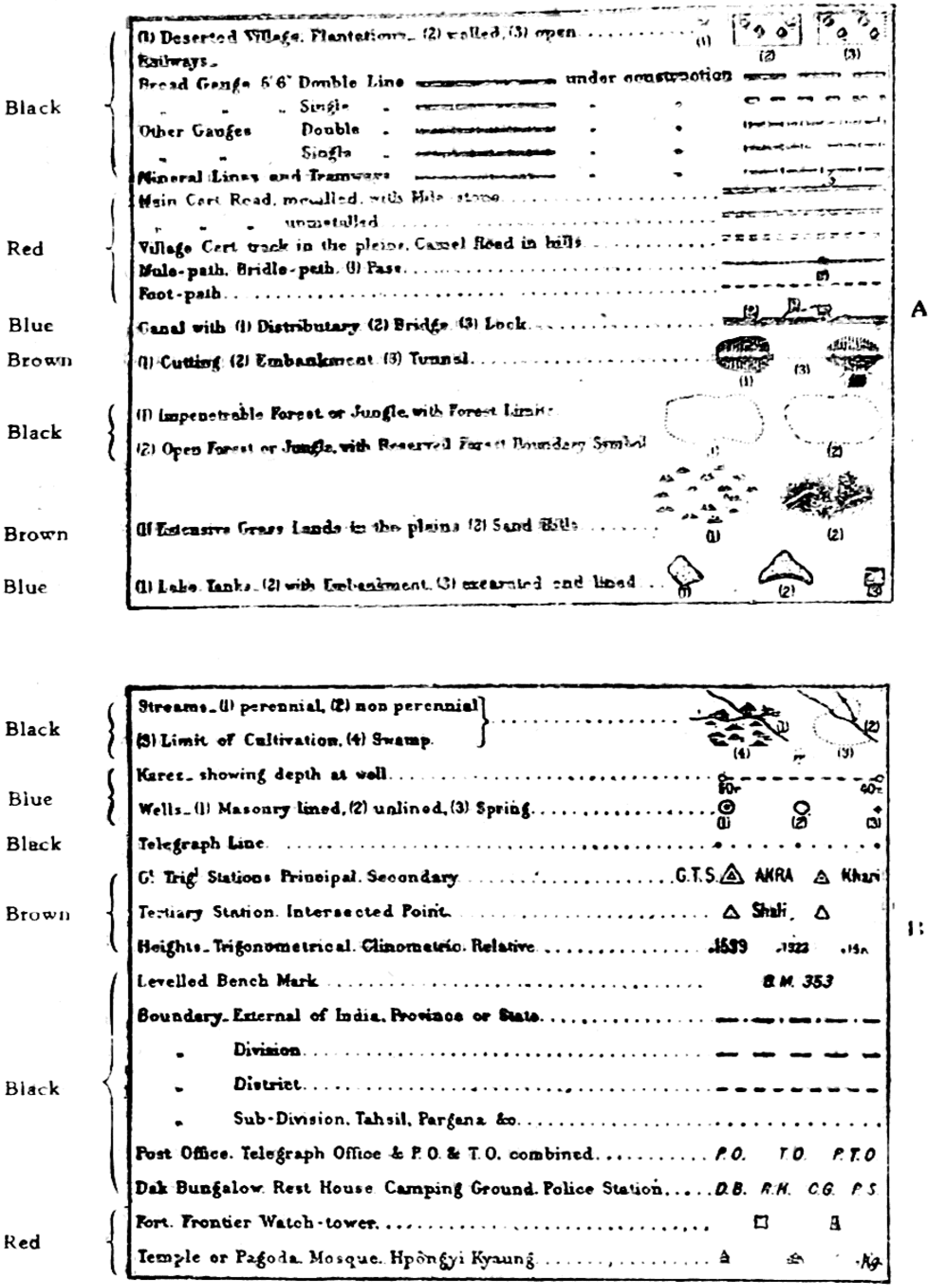
Black
(1) Deserted Village. Plantations_ (2) walled, (3) open
(1) (2) (3)
Railways_
Broad Gauge 5' 6" Double Line
under construction
Single
Other Gauges Double
Single
Mineral Lines and Tramways
Red
Main Cart Road, metalled, with Mile-stone
unmetalled
Village Cart track in the plains, Camel Road in hills
Mule-path, Bridle-path, (1) Pass
Foot-path
(1)
Blue
Canal with (1) Distributary (2) Bridge (3) Lock
(1) (2) (3)
A
Brown
(1) Cutting (2) Embankment (3) Tunnel
(1) (3)
Black
(1) Impenetrable Forest or Jungle, with Forest Limits
(2) Open Forest or Jungle, with Reserved Forest Boundary Symbol
(1) (2)
Brown
(1) Extensive Grass Lands in the plains (2) Sand Hills
(1) (2)
Blue
(1) Lake. Tanks_ (2) with Embankment, (3) excavated and lined
(1) (2) (3)
Black
Streams_ (1) perennial, (2) non perennial
(3) Limit of Cultivation, (4) Swamp.
(1) (2) (3) (4)
Blue
Karez_ showing depth at well
50 40
Wells_ (1) Masonry lined, (2) unlined, (3) Spring
(1) (2) (3)
Black
Telegraph Line
Brown
Gt. Trig. Stations Principal. Secondary
G.T.S. AKRA Khari
Tertiary Station. Intersected Point.
Shali
Heights_ Trigonometrical. Clinometric. Relative
.1539 .1322 .15r
B
Black
Levelled Bench Mark
B.M. 353
Boundary. External of India, Province or State
Division
District
Sub-Division, Tahsil, Pargana &c.
Post Office. Telegraph Office & P.O. & T.O. combined
P.O. T.O. P.T.O
Dak Bungalow. Rest House. Camping Ground. Police Station
D.B. R.H. C.G. P.S.
Red
Fort. Frontier Watch-tower
Temple or Pagoda. Mosque. Hpôngyi Kyaung
Ky.

Fig. 34. Conventional Signs used in Survey of India Sheets (as given by Stamp.)

Note.—Marginal remarks denote actual colours used in maps form lines and other possible height representations, (2) any special features are to be noted, (3) Physical divisions, if possible and (4) Types of rocks and soils if indicated therein.

(*d*) *Drainage (or Hydrogrophy).*—(1) The directions of the rivers and streams. (2) any water-divides. Description of any lakes, wells, tanks or water reservoirs.

2. **Human Geography.**

(*a*) *Historical.*—Is it possible to get an approximate ideas about the History of the area? This can be known from the presence of any forts, holy buildings, churches, temples, deserted sights, burial ground, battlefield (with dates) etc., etc.

(*b*) *How the land is being used.*—(1) Area under forests, (2) area under meadows and pastures, (3) arable land, (4) and useless or desert land. In Great Britain land utilization survey has already made tremendous progress under the stimulating directorship of Dr. Stamp. Many reports have already been published. Similar surveys are a great necessity in this country.

Irrigational works like canals and tube-wells also indicate the state of agriculture in the particular areas.

(*c*) *Means of communications.*—Railway lines (various gauges), roads (all types), navigable rivers, aerodromes etc.

(*d*) *Town sites* and *Village sites.* From this we can easily know the population and the state of culture and development. Presence of buildings etc. also help in this direction.

(*e*) *Occupations.*—Any mills, mines, factories, etc., industrial centres.

Setting a map.—This means finding the North to South line on a map. In an atlas map it usually runs parallel to the sides. There are however several other methods of setting a map.

(*a*) **By compass.**—Put the map flat on the ground and place the compass on it. Then gently rotate the map until the N and S line coincides with the compass needle. This method is, however, possible only in maps when a North-South line is given. In some maps (specially British) both the true and magnetic north are indicated. This is the best method.

(*b*) A map may also be set by laying it along the line of a road, river or any other straight feature. The same is then identified in the country. The map is then placed so that the particular feature on the map lies parallel to its counterpart on the ground. The north on the map is then noted and its direction in the country taken accordingly.

(*c*) A map may also be set *without a compass* if a clear land mark such as a church, clock tower or a group of trees, is visible. The above landwork may first be identified on the map and then the map turned until the line from the observer to the feature points to the actual feature on the ground. The north on the map will roughly correspond to the north in the country.

(*d*) By observing the position of heavenly bodies like the pole star and the sun.

(*e*) By means of a watch or a stick. These methods have already been explained in the section on 'Directions' in Part I.

A few examples in map reading are given for the guidance and benefit of the student. Owing to abnormal conditions, it has not been possible to reproduce actual maps read. In the end two maps from British Survey have also been read. The account of the Mirzapur sheet has been summarized from Dr. R. N. Dubey's 'Maps' because it is one of the finest accounts, the authors have come across.

Examples in map reading I

Sheet No. 63 K/12 (Mirzapur Sheet)

Scale 1 inch to a mile
or 1/63,360

(Including parts of Mirzapur and Benares Districts
and Benares State.)

The two outstanding features of this map are :—

(*i*) the Ganges, and

(*ii*) the Vindhyas.

From many points of view the Ganges is a more important feature, as most of the area is built up from its alluvium. The river flows in a meandering course; in fact, due to the alluvial nature of the plain, all the rivers present in this sheet have meandering courses. There are two loops of the meanders of the Ganges in this sheet, one, the narrower one, to the left and the other, the wider one, to the right. The narrower loop is important, because it centres at Mirzapur, which is the largest town of the area under study. The map shows that the current of water is always near Mirzapur, so that this part of the bed is never dry. The larger loop to the right is characterised by a very wide bed, in some parts about two miles wide. A large part of this bed consists of dry sand.

Owing to the meandering nature of the river, the banks are shelving in some parts and steep in others. Where the banks are shelving the flood water of the river spreads over large areas in the neighbourhood. But where they are steep, the flood waters are contained within them without invading the neighbouring areas. This is shown by the fact that on the side of the shelving banks, the villages are situated far away from the river. On the side of the steep bank, on the other hand, they are situated close to the bank.

The Ganges is not bridged at any place in this map. It is a wide river which is very costly to bridge. It has, therefore, been bridged only where traffic justifies it. In this map we notice that there are no large concentrations of population on the other side of the river from which large traffic could come. Mirzapur and Bindhachal are the only towns with large population, but they are both on the same side of the river. So there is no need for a bridge in this area. From November to June the Ganges is crossed by a Pontoon bridge at Mirzapur. There are eight places on the Ganges in this map where there are permanent boat ferries. Three of these places are near Mirzapur, which is natural considering that Mirzapur is the district as well as the largest town on this map and is, therefore, the focus of the area around it. Considering the number of boats at each ferry place, the most important ferries, outside Mirzapur are those at Bindhachal (connecting it with Harsinghpur) and Bhatauli Ghat (connecting it with Baraini and thence with Kachhwa, the largest town on the north side of the river).

All the tributaries of the Ganges on this map come from the south, from the Vindhyas. Among these tributaries the most important ones are the following :—

(*a*) Chartar Nadi,

(*b*) Kuardari, known in the middle course as Madho Nadi and in the lower course as Khajuri Nadi.

(*c*) Harral Nadi. (The famous Tanda Falls are situated on this river in its upper course).

(*d*) Ojhala Nadi, joining the Harral near Mirzapur.

Some of these tributaries are dry, except in the rainy season. This is specially true of the Khajuri Nadi. Besides these tributaries there are a number of Nalas which carry the surface drainage when it rains.

Some parts along the tributary rivers are marked by the badly cut up ravine lands. The most extensive area of ravines is found along the Chartar Nadi and the Harral Nadi. The river itself is characteristically free from ravines.

There are also a large number of tanks on this map. All, except two, are, however, small tanks. Some of the tanks are generally dry, except during the rains. There are two tanks, Tandadari Tal and Chandewa Tal, which are very big and have water throughout the year. The significance of the Tandadari Tal is that it supplies water to Mirzapur, situated about nine miles to the north. The water is taken through a pipe line. The Vindhyas and their foothills occupy about a third of the map in the south. They are a highly dissected plateau, with its steep escarpment facing the south or the east. The plateau is generally about 500 feet in elevation. It descends towards the north in two steps; the first step is about 550 feet above sea level and the second about 350 feet. The descent is very steep, making in some places a slope of about 7. The Mirzapur—Robertsganj Road, for example, has a slope of about 5 which is considered to be a very steep slope for a road; the best roads have the maximum slope of 3.

There are a number of flat rounded top hills both on the top of the plateau as well as at its foot. The highest hills are naturally those further south. Thus the Deophulwa to the east of the Robertsganj Road (683 feet) is the highest hill. This hill is a conical hill rising steeply on the top of the plateau. Other hills on the plateau are the Murli (648 feet), the Rajghat (571 feet) and the Bamhandewa (515 feet). The Bamhandewa is characterised by a very extensive and flat top.

Among the foothills the most numerous are those situated in the south-eastern part of the map. The most conspicuous foothills are the Shanker Pawa (549 feet); the Tharpahra (500 feet) being joined by a saddle to another hill 490 feet high, the Kugahi (523 feet). Besides these, there are several low hills further north, the two important examples being the hills near Pahara Railway Station on the Main Line of the E.I.R., and the hills near the Rifle

Range to the south of Mirzapur. The latter are only about 300 feet high.

The significance of the foothills lies in their giving rise to stone-quarrying.

The river valleys on the plateau are broad with steep walls. Note, for example, the Valleys of Jamthua and its tributary, the Dhaunia. Similarly, the valleys of the Kuardari and the Harral in their upper courses on the plateau are broad ones.

But as these rivers cross the plateau to reach the Ganges to the north, they have to pass through narrow gorges with steep walls. This is true almost of every river coming from the south across the plateau. The most significant example is that of the Kuardari which passes through the longest gorge on this map.

Most of the area on this map is shown to be cultivated. The only areas which are not cultivated are on the plateau or in the ravines where the soil is unfit for cultivation. The plateau region and the hills are generally covered by mixed forests. These forests are most extensive in the area to the east of the Mirzapur-Robertsganj Road, and near the Tandadari Tal. The areas that are not covered by forests are covered by grass or scrub. The most extensive areas of this later type are to the west of the Robertsganj Road and in the ravines of the Chatar Nadi.

The area shown on this map is predominantly agricultural. The distribution of the population is, therefore, essentially rural ;*i.e.*, it is found (*i*) scattered in small villages and (*ii*) is concentrated to some extent only in the market towns which very often happen to be also the administrative towns for the surrounding area. Villages are more numerous in fertile part. Generally, the soil near the plateau is less fertile than near the Ganges, especially to its north. Much larger villages are, therefore, found north of the Ganges than near the plateau.

Mirzapur, being the district town and a great market for the produce of the area around, is naturally the largest town on this map. It is situated on the right bank of the Ganges where the steep banks of the river prevent the flood water from spreading to Mirzapur side. The river is also the narrowest in this part, so that it can be easily crossed.

Bindhachal, Khamaria and Kachhwa are the other towns of note. They are all administrative towns, while Khamaria has the distinction of having a carpet factory.

The plateau region is almost without any settled population. The most populated parts in the south are to be found in the wide valleys of the river where agriculture can be carried on. Of these valleys, the valleys of the Chartar Nadi and its tributary, the Simaria, are the most important in this respect.

Apart from the hills, there are four areas which are particularly deficient in settled population. These are:—

(*i*) Area north of Bindhachal;
(*ii*) Area south of Bindhachal;
(*iii*) Area north of the railway line between Pahara and Jhingura stations;
(*iv*) Area south-east of Kachhwa.

Among these, the areas situated to the north of the Ganges, *i.e.* (*i*) and (*iv*), are without settled population owing to the danger of floods. Those to the south of the Ganges, *i.e.* (*ii*) and (*iii*), are infertile.

Mirzapur being the nodal point in this map, most of the lines of communication centre on it. A glance at the map will show that most of the lines of communication are in the western half of the map. This is to be expected because most of the population of the area is to be found in that part.

It is striking to note that railway communications are deficient in the area. This is to be expected from the absence of many large towns in the area. Mirzapur and Bindachal, the only big towns in the area, are close to each other and lie in the general direction followed by the main line of the East Indian Railway. If Bindhachal had not been in this general direction, it would have been necessary to build a branch line of the railway to connect it to Mirzapur. The existence of the Vindhyas in the south acts as a barrier for any railway line to approach from that direction.

The two railway lines that serve this area are (*i*) the East Indian Railway from Calcutta to Ghaziabad, and (*ii*) the Bengal and North Western Railway from Bhatni to Allahabad. The B.N.W.R. has also a short branch line to connect Mirzapur to the line going to Allahabad. The branch line stops at Mirzapur Ghat without crossing the river. Thus, a generalised picture of the railway communications on this map may be two parallel lines to serve the country on the two sides of the Ganges with a short branch almost connecting them near Mirzapur. It may be of interest to point out that the E.I.R., not only serves Mirzapur directly, but also the numerous quarries that lie near it, to the south of the Ganges. The B.N.W.R., on the other hand, serves the rich agricultural land to the north of the Ganges. A feature of the railway lines on this map is the long stretch of embankments on the E.I.R., the longest being between Pahara and Mirzapur, and the other two between Mirzapur and Bindhachal. In some cases the embankment is as much as 15 feet above the general level. A similarly long stretch of embankment marks the branch line of the B.N.W.R. A short stretch of embankment is also to be found on the B.N.W.R. going to Allahabad.

There are some good roads in this area, but, as mentioned above, these are mostly in the western half of the map. There are two first class roads, both running generally north-south. There is no first class road running east-west. The relative distribution of towns is the chief explanation. These first class roads are (*i*) the Great Deccan Road, which comes to Mirzapur only to join the Grand Trunk Road lying to the north of this map, and (*ii*) the Mirzapur-Jaunpur Road which crosses the Grand Trunk Road. The Mirzapur-Jaunpur Road crosses the Ganges at Mirzapur by a Pontoon bridge which is dismantled during the rainy season.

There are a large number of secand class metalled roads. They are also situated mostly in the most thickly populated area, the western half of the map. The most important of these second class roads are those connecting Mirzapur to Bindhachal and Mirzapur to Robertsganj. Several other second class roads have been built to serve the stone quarries in different parts of the map.

The effect of stone quarries on communications is intimate. Thus, the road from Toswa Parsia to the bank of the Ganges is entirely for the benefit of the quarry near Toswa Parsia. Similarly, the road from Jhingura, on the E.I.R., runs to the Vindhyas, crosses the Robertsganj Road and thence runs along the foot of the plateau and goes finally to Mirzapur by the Great Deccan Road. This road serves the largest number of quarries on this map.

The railway siding from Pahara, on the E.I.R., is also an example of the influence of stone quarrying on communications. It will be noticed from the map that stone quarries are generally located on the outer skirts of the plateau or on the foothills, which can be made easily accessible.

A number of unmettled roads are also found on this map. The largest of these radiate from Kachwa which is a market town and serve the area far off from Mirzapur. The area near Kachwa is not only far off from Mirzapur and separated by a wide bed of the Ganges, but is also a rich agricultural land. This can be seen from the large size of the villages.

Other unmettled roads are a continuation of the second class mettled roads only ; *e.g.*, to Pandari Shivgarh or to the Tanda Falls and beyond to Sirsi.

A large number of tracks or footpaths cross the plateau region in all directions to serve the forest area for exploitation.

It is noticed that the areas deficient in population, mentioned above are also deficient in communication lines.

A minor feature of the map is the pressure of the large number of lined wells. These wells abound in thickly populated areas. They, however, disappear from the areas in the neighbourhood of the Ganges where water for domestic purposes can be drawn from the river, and in the plateau region where it is difficult to dig wells and where there is no settled population.

This map is typical of the Gangetic plain where it borders the peninsular region of India. It provides an example of the plateau region as well as of the Gangetic plain. Agriculture, stone quarring and forestry naturally rule the life of the people in such areas.

II

Topography of the Vizagapatam District (Madras)

Number of the sheet : No. 65 $\frac{J}{12}$. Survey of India.

Magnetic Declination about 1°0′W (Increasing by about 5′ annually).

Scale 1″ to 1 mile.

The area lies between latitudes 18° and 18° 15′N ; and longitudes 82° 30′ and 82° 45′ East.

Relief.—All this area is mountainous and belongs to the Eastern Ghats or Karomandal range. There is continuous mass of mountains to the west side of the Mackkand river. On the Eastern sides the hills are separated from each other by river valleys. The hills rise abruptly from the valleys. At certain places they rise like a wall as we see on the Northern part of Mackkand river in B1. The hills are fairly deeply dissected. The valleys are steep sided, the slops being very steep. In the upper portion of Mackkand river and its tributary Bonga Gedda the valley is from one to two miles broad. The slopes of the hills are in general regular, at some places and often on summits they break into rocky cliffs. There are no plateaus ; all are folded mountains. The valleys are made of alluviam washed down from the hills. All these valleys are used for agriculture. The average height of the hills is between 4000 and 5000 feet above sea-level.

Hydrography.—The general slope of the country is from South to North. All the streams take their rise from the forest covered hills. Rivers naturally follow the general slope, *i.e.*, they flow from South to North. The drainage pattern is simple and ordinary. It is consequent drainage. There is no definite waterparting. There are small well directed ranges. Each range has got its own waterparting. There is no instance of a river capture in this area. The rivers are in adolescent stage. They are rushing torrents near their sources moving big blocks of stones and rolling big bolders down streams. At certain places rivers enter gorges and have steep sides. The general slope is steep and hence the water flows with considerable speed. The valleys are not symmetrical due to the difference in the strength of rocks to resist. All the streams meander and have got interlocking spurs. The drainage is plentiful and profuse and well developed. There are no lakes, but there is one seasonal lake on the top of the hill in A1 at 4035 feet high. It appears that the North Western area is made of limestones at certain places. This dry lake or depression may be due to underground solution. On certain hills in the North Western portion there are no forests. The hills are covered with grass only. That also show's that the rock is porous and cannot support life.

Vegetation.—The hills are profusely covered with woods. Considerably thick deciduous forests are found. It seems that they are not much used commercially as the means of communication are very poor. Limestone rocks are devoid of trees. Short grasses are found there.

Settlements.—The area is very mountainous and thickly forested. Means of livelihood are scarce, agriculture is carried on only in the narrow valleys along the rivers, as is shown in the map in yellow colour. The means of communication are very poor, hence there is no big settlement in this area. There are scattered huts connected by mule and foot paths. All the paths keep along the river valleys and gaps. Pata and Gangarajumabugoln and Bolumil are settlements of some importance in this area. The small huts which are near the forests must be either of lumberers or herdsman. Huts are a little away from the streams which shows that the streams are liable to flooding. There are a few rest houses and some temporary settlements in this area.

Occupations.—The region seems to be an unimportant one, due to the lack of communications. As there is an abundance of trees on the mountains, lumbering probably is the main occupation of the people; and the wood is probably sent to other places also, through the rivers.

Agriculture is probably carried on in the narrow plain valleys of the main river Mackkund.

III

Topography of Central India—Gwalior and Rajputana.

The Number of the Sheet—No. 55 $\frac{\text{E}}{\text{N.W.}}$.

Magnetic Declination about 0° 10′ East in 1981 (Decreasing by 4′ annually).

Scale 1″ to 2 miles.

The area lies between 23° 30′ north latitude to 24° north latitude; and 77° to 77° 30′ longitude.

This region contains the districts of Narsinghgarh, Berasia, Wazirabad and Kotada.

Relief.—There is a mass of low hills on the Eastern side of the valley of river Parbati. The average height of the hills is between 1500 to 1700 feet above sea level. Some peaks rise upto 1891 feet. Contour 1500 feet passes through the middle of the area and then again to the west of the river the contour 1500 feet marks small isolated hills. The slopes are very gentle and the hills have been well dissected by small streams. The hills have somewhat flat tops in most cases as it is in the Jhalwar state Forest in A2, A3, B2 and B3. There are small isolated hills on both sides of the river generally rising over 1500 feet. It shows that these rocks are made of more resistant material. At some places the streams have made ravines and broken the ground and are responsiqle for much waste land. Such examples are found in all the seasonal tributary streams of the river Parbati. River Parbati itself has got steep banks at some places rising up to sometimes 45 feet or 60 feet. In only a few cases the hills end in plains abruptly making cliffs as we can see in 4B and 5C, but generally they end by very gentle slopes. The plain is made of alluviam washed down from the hills and deposited in some early age ; but now there is no longer any deposition, as the streams have more graded slopes and deep vallies.

Hydrography.—The general direction of the main streams is from South to North in this area. The pattern of the major stream is consequent. All the streams take their rise from the forested Hills. Most of the streams are seasonal but in most cases when they come to the plains they become perennials which shows that the rocks are porous in the upper strata and the lower strata is definitely impervious. All this area is pierced with wells like a sieve. It shows that the water table is sufficiently high both on hills and on plains. The rock does not seem to be very hard as there are wells even at the top of the high lands.

Drainage pattern in general is radial as the streams flow towards all directions. As the drainage is radial hence water partings are at the tops of hills and peaks. The stage of the development of drainage is between mature and adolescent. The main river has small meanderings. In some places near the hills the bank is as steep as 60 feet but at other places it is almost level with the rest of the country as there are no bridges but fordes. The beds of the streams are covered with gravel, big stones and rocks at some places. The drainage is partially underground because some streams start as seasonals become perennials and again become seasonals, *e.g.*, in A4—Baria Nala. There are a few small tank-like lakes, on the hills, *e.g.*, in C5, E6 and B4. As all these lakes are on the highlands ; probably they have been made *by solution.*

Vegetation.—The hills and plains are covered with deciduous forests. The hills are comparatively thickly forested. There are also high and tall grasses on the hills at some places. A few shrubs are also found. There are low grasses along the rivers and in waste lands. The distribution of vegetation gives a hint about the rain fall which is between 15 to 25 inches annually.

Settlement.—There is only one big town in this area. Narsinghgarh is situated in B4. The area of the town is about 1 square mile. Three first class metalled roads meet in this town. Narsinghgarh has a palace, a fort, a court, a police station, a post and a telegraph office and a lake. It is also a model town and is on the edge of the plain. Berasia in 5 F is a small linear town with post and telegraph offices and a police station. From the town roads go to all directions, one is a first class metalled road. There are many unmetalled roads. There are small huts here and there, all realtered, most of them connected by ordinary paths.

Communications.—All the metalled roads keep along the water parting so as to avoid some seasonal torrents. Relief is not so impossible hence roads do not regard it, and in most cases they keep away from the streams. There are no bridges ; the rivers are crossed at fords. Telegraph connects Berasiea and Narsinghgarh. The villages have markets on certain days of the week.

Important towns.—The most important town is Narsingh Garh followed by Berasia. The smaller towns are Wazirabad and Lakauwas. There are many villages, the greater number being in plains.

Industries.—Agricultural industries are followed in the plains, and probably the timber industry on the highlands. On the whole this region seems to be an unimportant one, probably due to its barren nature, which may be seen by the lack of irrigation works and poor means of communication.

EXAMPLES OF BRITISH SURVEY SHEETS [1]

I

Topography of Gloucester and Forest of Dean

Number of sheet—No. 92 Ordnance Survey of Great Britain.

Magnetic declination 14″ 34 W (decrease by 10)″. Scale 1″ to 1 mile.

The area lies between latitude 51.48N and 52.48N, and longitude 2.5 W to 2.40 W.

General Relief.—The region is an undulating plain, rising up to 900 feet above sea level in the South east and South West. There are a number of small hills all over the area. The highest point is in the south east, being about 984 feet near Birdlip.

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[1] **Given only by way of illustration.**

Drainage.—The main rivers are River Wage, River Avon and the River Severn.

River Upe in the west flows from north to south. It makes a gorge in the South-west and it meanders in its wide plain. River Severn also flows from north to south, passing through the important towns of Tewkesbury and Gloucester. The river changes its course in the south leaving a sandy plain.

The River Avon coming from the north east, joins the River Severn near Tawekesbury. Another River Deadon flowing from the northwest, passing near Dedbury joins the Rivers Severn and Avon near Abney Island.

The valleys of the rivers, in the east especially have many drainage channels, which show that the area is probably wet. There are a few important canals in this region. In the south east is the Gloucester and Berkley Canals, having at its head the important town of Gloucester. The other canal is the Coube Hill Canal in the east, which is probably not used now.

Natural Vegetation.—All over the country there are patches of woods, especially in the south west, north west and also in between. The country seems to be devoid of any other kind of vegetation except for the woods.

Cultural features

Roads.—The country seems to be well supplied with, both first and second class roads. The main roads connect the important towns of this region.——Tewkesbury, Cheltenham, Gloucester, Ross and Ledbury.

Railways.—There are a number of railway lines, connecting the different parts of the country with one another. Some of the important stations from where the railway lines converge are Cheltenham, Gloucester and Ross. Another line connects the chief towns of the west-Lydbrook, Walford, Ross and Hulme Lacy.

Important towns.—Gloucester in the south west seems to be the most important town. Railways and roads connect this town with other important towns of the region. It seems to be an industrial centre.

Cheltenham is another important town in the east. This is also a centre for important routes.

The other towns of importance are Ross and Ledbury.

Industries.—The country being mostlv wooded, lumbering probably is the chief industry, which may be giving rise to the paper-making and wood-pulp industries. Agriculture is another important industry, mainly in the east. The presence of word 'Fm' shows that there are many farm lands.

The important cities, Gloucester and Cheltenham seem to be industrial centres, where manufacturing industries are carried on.

II

Topography of the Isle of Weight

The number of the sheet—No. 141—Ordnance Survey of Great Britain.

Scale: 1″; 1 mile.

The Isle lies between 52° 34′ to 46° N latitude and occupies a central position in the lower half of the sheet.

Relief.—The country in general is hilly and rocky, having the highest peak in the south east about 787 feet above sea level; and the lowest in the northwest near Yarmouth, about 17 feet high. In the middle of the island there is a long ridge running from east to west, the height does not exceed 500 feet except at certain triangulation stations. The general slope of the country is towards the north, and also a little towards the south and east. The northern coast has a number of estuaries and the southern coast has broken cliffs.

Drainage.—The main rivers are River Medina and River Yar.

The River Medina flows from the south towards the estuary in the north, cutting through the Central Ridge.

The River Yar in the west also flows from the south to the estuary in the north west near Yarmouth.

There is another River Yar flowing towards the north east in the Brading Harbaur. There are a number of other streams flowing towards the south east; and in the east small canals are also found.

Natural Vegetation.—All over the country there are patches of woods, specially in the north west and north east, and also between Calbourne and Brightstone. Here and there can also be found a few orchards. There are some patches of rough pastures by the sides of the Rivers.

Cultural features

Roads.—The country is well supplied with roads connecting one part of the country with the other. There are both first and second class roads; and the rest of the country is also connected with metalled roads. The roads connect the harbours—Yarmouth, Cower, Ryde, Foreland, Sandown, Shanklin, Ventuor, and all these roads meet at Newport.

Railways.—Railway lines converge from Newport to Cowes, Yarmouth, Sandown and to White Hall. There is another railway line from Freshwater to Yarmouth in the east. Ryde is also connected by a railway line to Newport.

Important towns.—Newport, occupies a central position on River Medina. It is well connected with roads and railways to all ports and important towns.

The other important towns are Yarmouth, Cowes, Ryde, Sandown and Ventuor; there are also important ports, and they are connected with the Hinterland by railways, and roads.

Industries or Occupations.—The country being hilly, agriculture is almost impossible. In the woods probably lumbering takes place, thus it might be giving rise to paper making and wood pulp industry. Probably sheep-rearing and farming is carried on whereever pastures are found.

For Practice

Take any large scale survey map preferably one-inch to a mile sheet of your home region and do the following exercises :

(*a*) Briefly describe the methods used for showing relief and describe their comparative effectiveness.

(*b*) Describe the relief features of the region.

(*c*) Mark off an area about six miles square and give a general description of the country shown in this area—its hills, valleys, streams, towns, villages etc. In this connection it may be helpful to trace the contours, mines, wards and railways, etc., separately and then place one on the other, *e. g.*, railway lines on contours and thus find out their inter-relation etc.

(*d*) Do the details in the map suggest a division of the area into regions,

(*e*) Comments on the distribution of population.

CHAPTER VIII

WEATHER MAPS

Indian Weather maps and reports which are issued daily by the Meteorological Office at Poona, show the weather conditions during a period of 24 hours from 8 a. m. to 8 a. m. ; and from these a weather forecast can be made. Some details about these reports have been given in the chapter on 'Atmosphere.' Here, however, it is our intention to tell you how to *read* such reports.

Pressure is shown by means of isobars in inches and millibars. Winds are shown by means of arrows → and their force is indicated by means of feathers on the arrows. Light air is shown by one feather and the number of feathers increases according to the velocity of winds. The velocity of wind is important to man, high velocity being rather harmful.[1]

Rainfall is shown by means of small circles having the figures, *e. g.*, ¼ within them to indicate amount of rainfall if it is more than ¼ of an inch ; an empty circle means ·10″ to ·17″ ·0″ to ·09″ is neglected. It is, therefore, very easy to find out the distribution of rainfall on a weather map.

The departure from normal both in the case of temperature and pressure is shown in separate maps given below.

The condition of the sea is shown by means of the following :—

SM = Smooth.
Sl = Slight.
Mod = Moderate.
Ro. = Rough.
V. Ro. = Very rough.
Hi = High.
V. H. = Very High.
Pr = Precipitous.
Conf = Confused.

While reading a daily weather map the following points are to be described :—

(*a*) Distribution of Barometric Pressure (& Pressure Gradients) along with the location of Bar High and Bar low.

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[1] Please also see the map attached.

(*b*) Pressure Departure from the normal.

(*c*) The Direction and force or Velocity of winds.

(*d*) Occurrence of rainfall.

(*e*) Temperature and departure of mean temperature of day from normal.

(*f*) Condition of the sea.

Below is given an example of reading a weather map for your guidance and it is hoped that it will show you the way to a fuller knowledge about the subject.

Example in reading a Weather Map of India

1. *Date.*—This map shows the weather conditions observed on Sunday, June 16th 1940 at 8 hours.

2. *Location of 'Bar low'.*—An area of low pressure is situated along Baluchistan coast and southern part of N. W. F. P. It extends from Dalbandhi to Miran Shah and Isobar of 23·45 in. (997· 3 mlbs.) makes the boundary of this area.

3. *Location of 'Bar high'.*—High pressure is found on southern side of Western coast of India. This area is located at sea near Minigoy and is far away from 29·85 ins. (1010.8 ml.) isobar in the Arabian sea.

4. *Pressure Gradient.*—The study of isobars reveals, that isobars are visiting from N. W. of India to South-West where we find the area of High Pressure.

There is uniform rising of pressure in Western parts of Sindh but as these isobar lines reach Eastern parts of Punjab. U. P. and the Slopes of the Himalayas, they are found spaced far apart and pressure is also gentle and winds weak. In the peninsular India pressure is higher than in North-East and North-West of India. The highest has been recorded on the western side of south India at Minigoy. In southern parts of Madras, Bombay and Hyderabad, winds are stronger than in Chota Nagpur and lower Bengal.

The departures for this day from the normal pressure are :—

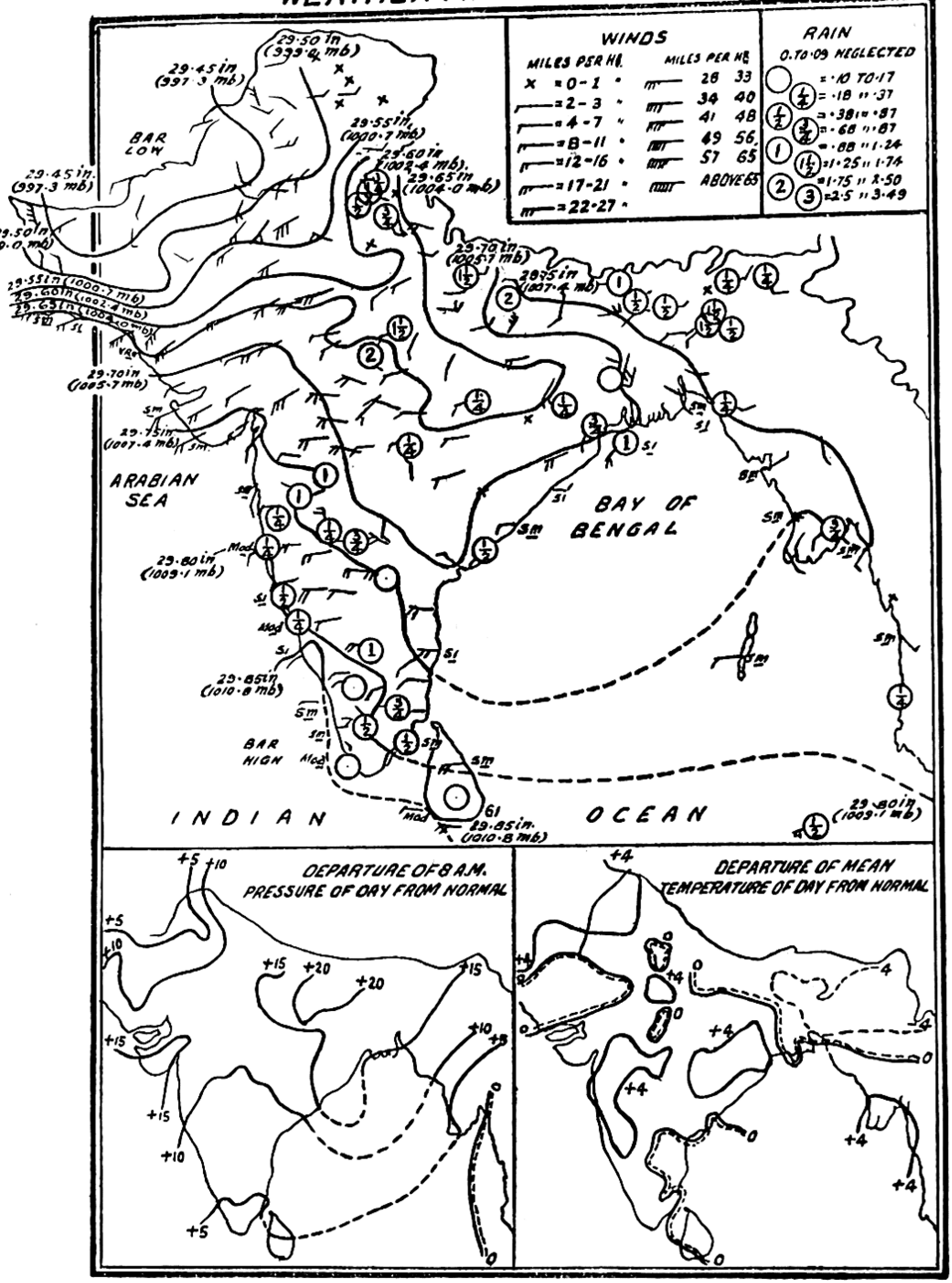
1. The pressure has arisen by +5 in the N.-W. F. P. and South India.

2. The pressure has risen by +10 at Las Bela, Bellary and Nellore.

3. The pressure has risen by +15 at Rajkot, Bhavanagar, Baroda and Surat on Western side and at Allahabad.

4. The pressure has risen by + 20 on the North Western side of Assam.

WEATHER MAP OF INDIA



Weather Map of India on the 16th June, 1940
(Reproduced with the kind permission of the Director, Meteorological Survey of India, Poona)

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5. There is no departure of pressure from normal in the Southern parts of Rangoon; while at Minigoy where pressure is already high, it has increased by +5.

5. **Winds**. (*a*) *Velocity.*—In N.W. of India winds are calm and blowing with the velocity of 1 to 3 miles per hour, and their velocity is increasing in Southern Punjab, Western Sind, C. P. Bihar and Mysore. In Central India the velocity is 8 to 12; in extreme south up to 17 and in Chota Nagpur and lower Bengal it is from 3 to 17 miles per hour.

(*b*) *Direction of winds.*—Winds are blowing from North to South-Western parts of India in the Punjab. U. P., C.P., Rajputana, Bombay, Madras and Lower Bengal. In the upper parts of Assam and Bihar winds are moving in a Northerly direction.

By studying the direction and velocity of winds for this day, we may say that (*i*) there is light breeze in the Panjab and Northern parts of India, (*ii*) Gentle breeze in C. P., Hyderabad, Northern parts of Mysore and West of Rajputana, (*iii*) Moderate breeze (raising dust and paper) in extreme South near Calicut, on Western Ghats (Bombay, Ratnagiri and Belgaum) in Chota Nagpur and Bihar.

6. *Rainfall*—(*a*)·North-east India including Orissa.—There has been general rain in Assam and local rain in Bengal, while a few falls have occurred in Orrisa and Chota Nagpur; the chief amounts are Cherrapunji 1·7", Sandheads 1·0, Balasore 8, Jalpaiguri 0·7, Shillong 0·6 and Dhukri and Silchar 0·5 each. Skies are lightly to moderately clouded in Orissa and moderately to heavily clouded elsewhere. Humidity is in defecit in Chota Nagpur and parts of Orrisa, Bengal and Bihar.

(*b*) U. P., Central India, C. P. and Bihar.—Rain has fallen locally in U. P. and at a few stations in the West.

(*c*) CentralIndia and C. P.—The chief amounts are Gorakhpur and Guna 2·3 each, Jhansi and Baharich 1·5 each, Roorkee 0·7, Nagpur 0·3 and Pendra 0·2. Skies are moderately to heavily clouded in U. P. in the west of C. P. and lightly to moderately clouded elsewhere. Humidity excess locally in East U. P. and low elsewhere

(*d*) North-west India.—A few falls of rain have occurred in the east and north Punjab, Ambala and Dharampoor reporting 0·6 each and at Simla 0·3. Skies are moderately to heavily cloudly in Lower Sind, lightly to moderately clouded in Gujrat and clear or lightly clouded elsewhere. Humidity is in excess in upper Sind and locally in defect in Kashmir, N.-W. F. P. Baluchistan east Rajputana and Gujrat.

(*e*) The Peninsula.—Local rain has occurred in the Kouteau, and a few falls in Bombay, Deccan, Hyderabad, Mysore, and the Madras Presidency; the chief amounts are Aurangabad 1·2, Ahmadnagar and Bangalore 0·9 each, Gulbarga and Trichinopoly 0·8 each, Pamban 0·6, Cocanada, Kodaikanal 0·5 each. Skies are lightly to moderately clouded. Humidity is locally in excess in Mysore, and in defect in parts of the Bombay and Deccan.

7. Temperature and departure of mean temperature of day from normal :—

(*a*) North-west India including Orissa.—Minimum temperature was above normal in Orissa and Chota Nagpur and below it in Assam.

There is no change in temperature in Sind but there is an increase by +4 in the Western Punjab plain.

(*b*) U. P., Central India, C. P. and Berar.—Maximum temperature was generally above, minimum was below normal in the east U. P. The maximum temperature is 109° at Agra.

There is no change in temperature except an increase in South West C. P. by +4.

(*c*) North-west India :—Both maximum and minimum temperatures were above normal in Baluchistan, Kashmir, and N.-W. F. provinces – 115° the highest at Khushab and D. I. Khan. There is an increase by +4 in Western Plain.

(*d*) The Peninsula.—Day temperature was higher than usual in the Konkan, Bombay, Deccan and North Hyderabad—highest 105° at Jalgaon.

There is an increase of only +4 in the Western part of North Madras, Mysore and there is no change in the extreme South.

8. Condition of the sea.—From Karachi to Trivandrum condition of the sea is smooth and slight except very rough at Karachi. As we pass on to the East coast there is no change in sea condition up to Calcutta and Rangoon. Sea is slight at Madras, smooth at Calcutta and Rangoon, and elsewhere.

For Practice

(*Note.*—The year does not matter while selecting weather maps for study).

1. Study the weather maps for the full week during the months of January, July and September and write down

the weather conditions for the respective weeks giving recsons for the difference in details and also give forecasts for the following eighth day after every week.

2. After a study of various maps, put a winter cyclone at Lahore and draw the direction of the winds. Also show the direction of winds if the same cyclone were a summer cyclone and give reasons for any difference.

3. Study the weather maps for the last week of June and account for the distribution of rainfall.

4. Take any weather map and answer the following :—

(*a*) Describe the pressure systems and their attendant weather conditions.

(*b*) Where are the strongest winds blowing ?

(*c*) Describe the conditions in the Arabian sea.

(*d*) Prepare a graph showing isobaric gredients from your home town to any place 1000 miles away (roughly).

CHAPTER XIV

REPRESENTATION OF GEOGRAPHICAL DATA

So far we have been talking about map-reading. Map-making is also a very important part of Geography. Maps and diagrams are drawn to represent statistics and other available data. Figures become more intelligible and less boring if they are expresssed graphically. Besides neatness, therefore, a map or a diagram (1) should convey to the the reader the main idea at a glance, and (2) it should contain all those items that one proposes to discuss in the text.

1. Something has already been said about *representation of relief* and that should be enough to enable you to show the various surface features on a map with some amount of accuracy.

Practical Exercise :—Draw a map with the following data using 'Survey of India' conventional signs. Let the scale be 1 inch to 2 miles and the contour internal 100 ft.

In the south the land rises rather gently from sea-level to a height of about 800 feet. Farther north it gets rather steep till a pass situated at about 1750 and 1820 feet is reached. Towards the north it drops rather steeply on the east and very gently on the west to a lake about 5 miles long and 3 miles broad lying at a height of about 500 feet. One main stream takes off a little below the pass, receiving two tributaries, it reaches the sea towards the south after making an estuary. Towards the north a number of streams flow independently into the lake.

2. *Climatic illustrations* include those showing temperature, rainfall and pressure distribution. Temperature is best shown by means of isotherms. Temperature graphs drawn on squared paper as shown in the (fig. 35), are drawn to show average monthly temperatures. Graphs are usually drawn to show monthly and daily temperatures. Sometimes graphs of two or more places are shown on the same figure and this enables a comparative study. Some people do not join the plotted points to make curves but join the points showing the month of the year or the

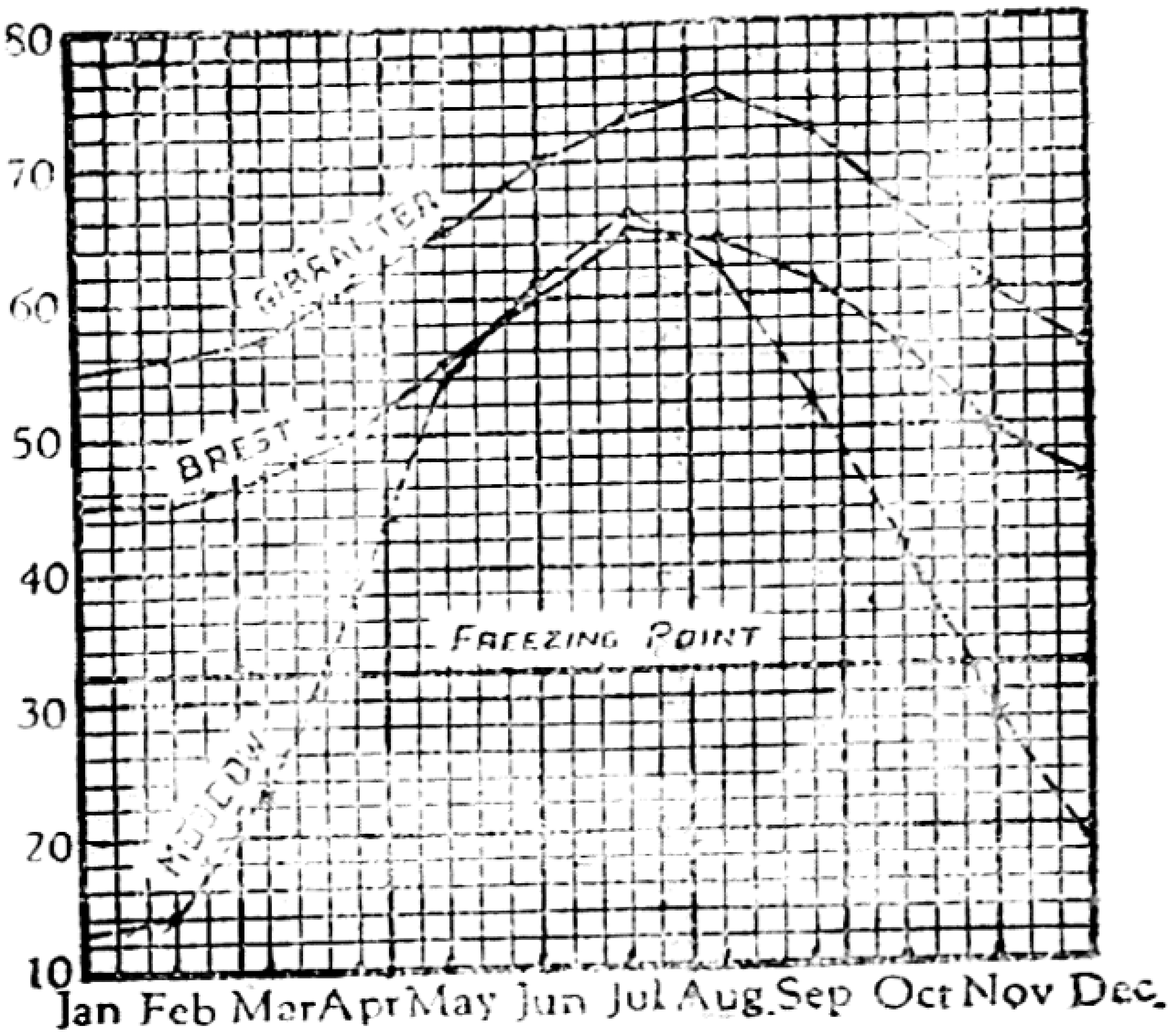

Fig. 35. Temperature graphs.

day of the month with its respective temperature point plotted on the squared paper, thus forming perpendiculars of varying heights. Whatever method is followed, it is but essential and more convenient to show the time element on the horizontal line and the temperature scale on the vertical line.

Average Rainfall Distribution is best shown by shading in a map, the shading getting darker with the increase in rainfall because the method at once gives an idea of the distribution. But this shows only approximate figures.

Monthly rainfall may be shown by means of graphs like those showing temperatures. It is, however, essential that rainfall and temperature be shown in separate diagrams so as to avoid confusion. In case they are both shown in the same figure, the two verticle lines at the two ends of the horizontal line should show different scale, *i.e.*, one may show rainfall scale and the other temperature scale. The two curves should also be drawn either in two different colours or some other differentiation be made, *e.g.*, the temperature curve may be dotted while the other one may be continuous. It is also possible to put in the same diagram two or more rainfall graphs.

Another method of showing rainfall is by means of vertical blocks as shown either in Fig. 36 or in Fig. 37 as the case may be. According to this method, however, it is not possible to use one diagram for more than one place and hence no comparative study is possible.

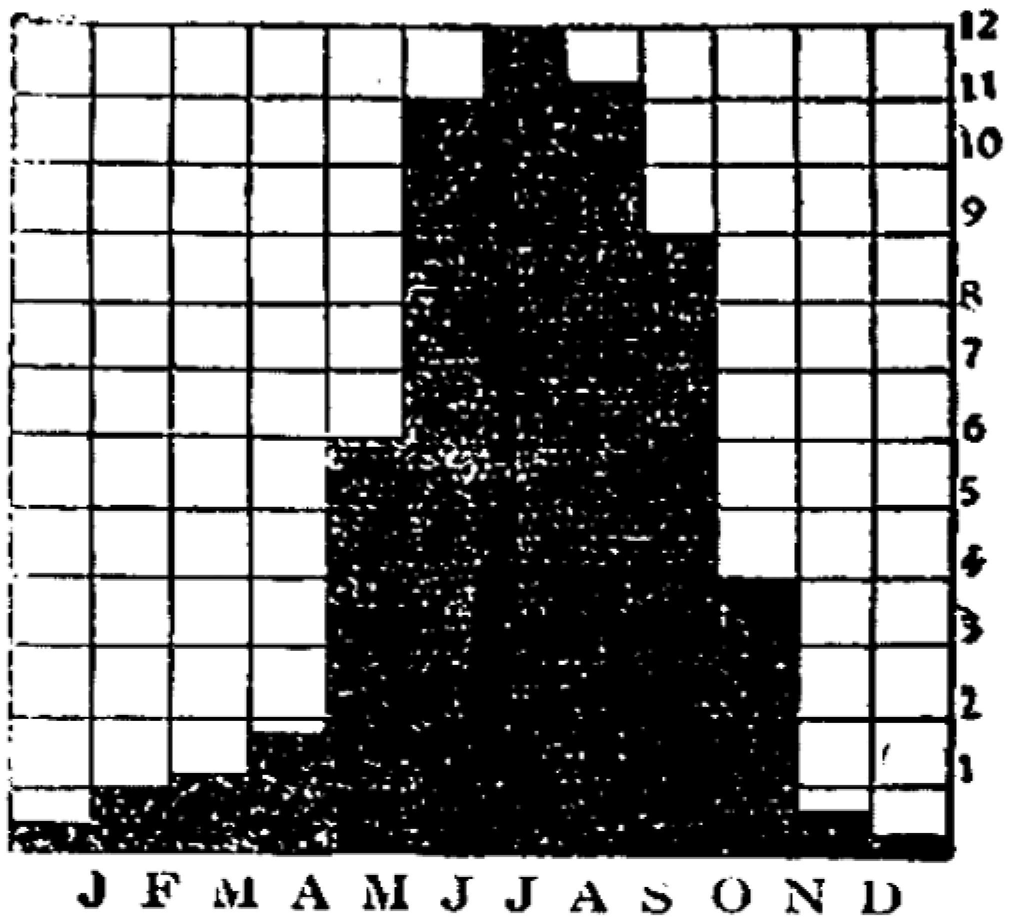

Fig. 36. Monthly rainfall of Calcutta.

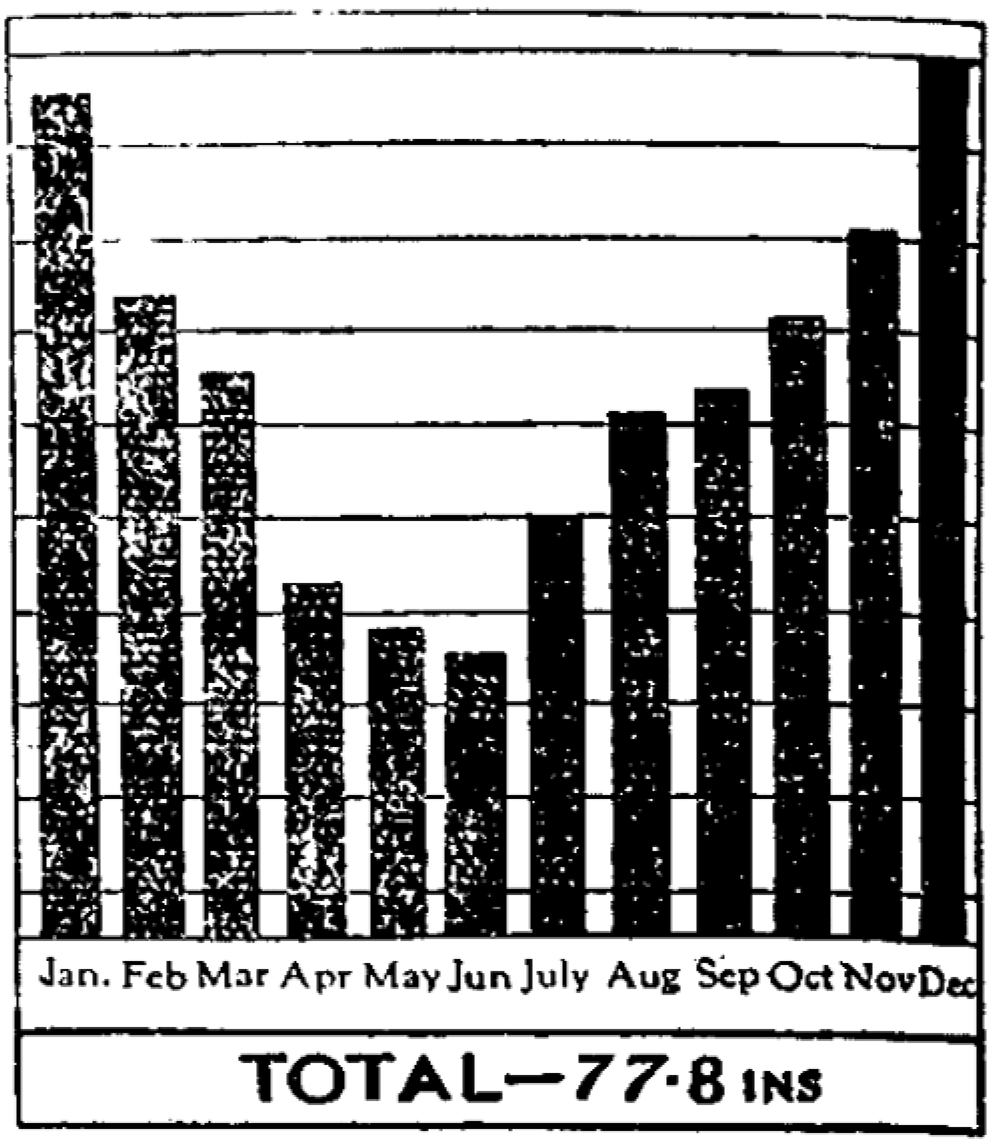

Fig. 37. Another Method of showing monthly rainfall.

(*c*) Pressure is best shown by means of isobars and the winds by means of arrows. The velocity of winds is shown by means of feathers as shown in Daily Weather Reports (The Beaufort Wind Scales).

(*d*) *Distribution maps* unlike topographical maps, show only the distribution of one 'commodity.' The rainfall, pressure and temperature maps described above (apart from graphs, etc.) may also be included in this category. There are many methods by which the distribution of a certain commodity, *e. g.*, density of population, or the production of some agricultural crops may be shown. Which method may be used depends on the scale and the purpose of the map and on the manner in which data is given.

(1) By means of lines joining places of equal value, *e. g.*, isobars, isotherms and isohyets. The lines are drawn at sufficient intervals to avoid overcrowding.

(2) *The Dot Method.*—This method consists in denoting a fixed amount of the commodity by a single dot, or sometimes choosing dots of different sizes, to represent various units. The size of the unit, to be represented by each dot is of great importance. It must not be so small that so many dots may have to be inserted in the area, as to produce a blurred effect. It must not be so large that accuracy may have to be sacrificed unnecessarily.

If the unit to be represented by each dot is carefully selected, the dot method is a very useful method in giving an idea of absolute figures rather than the average.

This method is useful only when absolute figures are given. If climatic and soil maps are given alongside these, we can exclude the areas where the commodity is not likely to be found. Dots can be concentrated in areas having the greatest concetration. They can be put more sparsely, where they are less important.

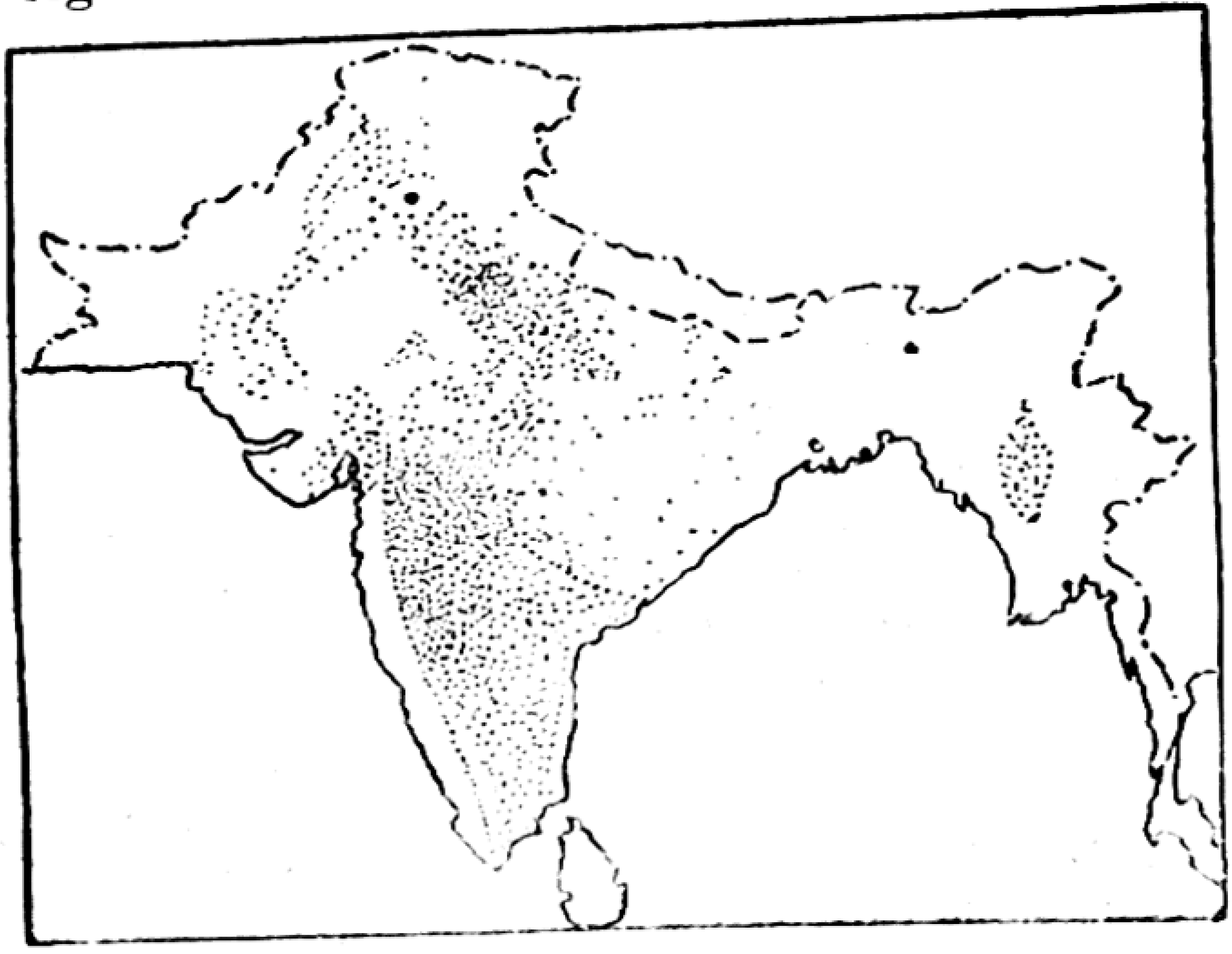

Fig. 38. Each dot represents 50,000 acres under Millets.

This method can also be used to represent density of population. In this case different dots must be used for towns in which great concentrations of population occur.

While calculating, less than half the unit is ignored while more than half is shown as one full unit. Better results can be had in large-scale maps.

The method is very useful if detailed information is available about an area and exact information is demanded on a map. Different shapes of dots may be used to depict the distribution of different commodities. The size of the dots may also be changed to show different units.

Population is difficult to show by this method as the variations by rural and urban population is marked and unless we have a very detailed information about these points it is difficult to give a very true picture. In the case of urban population which is very dense, it is often impossible to fit the required number of dots in the specified space, *e.g.*, the population of London or New York is difficult to be shown.

(3) The Layer-tint or the Shading Method is useful where only average conditions are to be shown. The density of population per square can be shown by this method and not the actual population. In order to make the respective areas clear, different lines or shading or colouring are used. The best way, however, is to use varying shades to

show varying valves. This method is very suitable for small-scale maps of large areas as such maps only claim to give a general view of things and not exact details.

Obviously in this method much depends upon the units selected as the limits for different kind of shading. Thus a particular shading or atlas colouring may show areas having a density of population varying from 150 to 250 and give no idea at all about the actual state of affairs. The greatest drawback of the method is that it gives a very erroneous idea of uniformity because it takes only averages into consideration. Combined with the dot method, however, this method may give better results.

(4) A very simple but very rough method of showing the distribution of commodities is to put down the first letter of the particular commodity in the area where that commodity is found, *e.g.*, W may be put in regions where wheat is cultivated. Many Ws may be put close together in places of abundant wheat cultivation. Some people write the word *e. g.* 'Cotton' itself across the area where cotton is cultivated. This method, however, gives no idea about the exact location of the crop and about the actual amount produced.

(*e*) *Statistical Diagrams* attempt to transfer dry 'tables' into concrete and easily readable diagrams.

(1) Fig. 39 shows graphically the amount of wheat and oats produced in Great Britain during 1921 1930.

The method is the same as followed in the case of temperature and rainfall and the graphs allow for a comparative study.

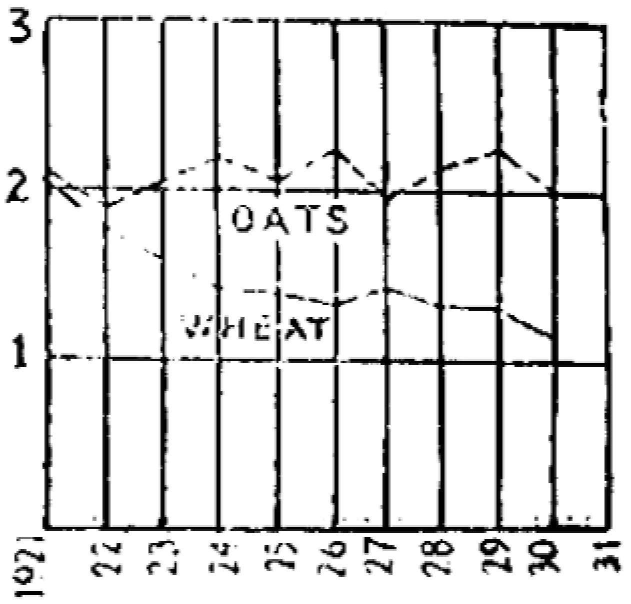

Fig. 39. (After Fry).

(2) Fig. 40 shows another way of showing similar items. The figure shows principal British imports as given by Stembridge. The length of the lines is taken according to the amount of the commodities imported. The width of the lines does not matter at all.

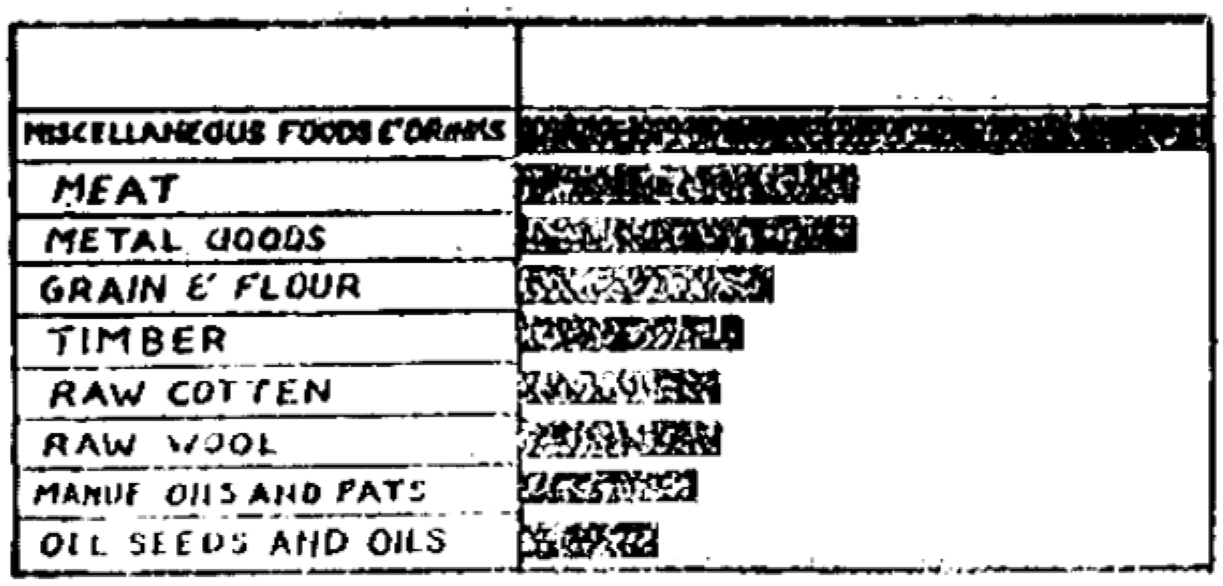

Fig. 40. Another way of showing comparative studies.
(*Note*—Read cotton for cotten).

(3) Fig. 41 shows diagrammetically the coal production of the various areas in England and Wales for the year 1930. This diagram is drawn on a squared paper. First a rectangle is drawn containing squares equal in number to the millions of tons of coal mined in England and Wales. Then this rectangle is sub-divided proportionately as shown in the figure.

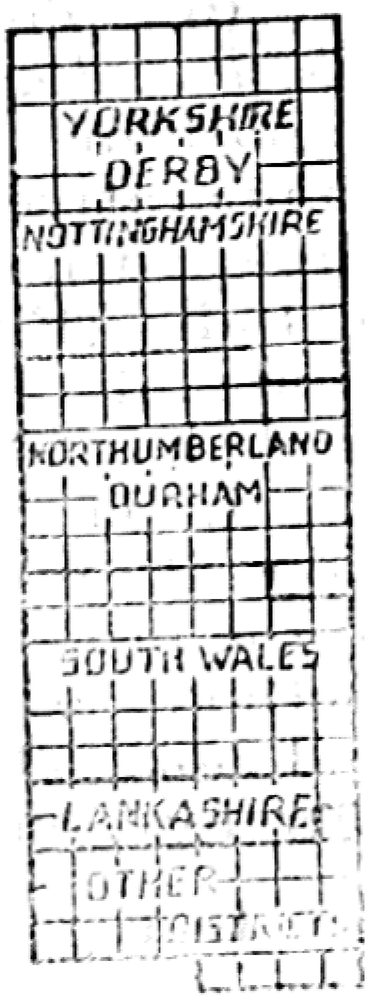

Fig. 41. Coal production in England and Wales (in 1930) by areas. (After Fry)

(4) Fig. 42 shows a simple method of representing comparative data. The whole length of the line represents total coal production of the world. Then it has been divided according to individual share (in percentage).

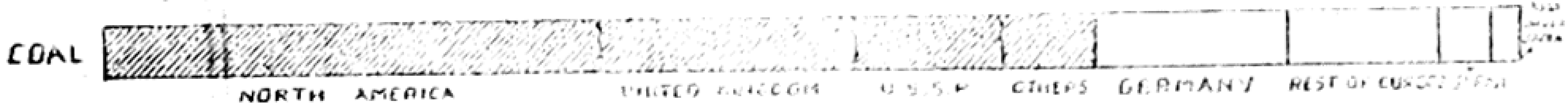

Fig. 42. World Coal Production (shaded in Allied Hands).

(5) The area of the rectangles in Fig. 43 is proportionate to the varying values. This can also be drawn on a squared paper, each rectangle containing the proportionate number of squares.

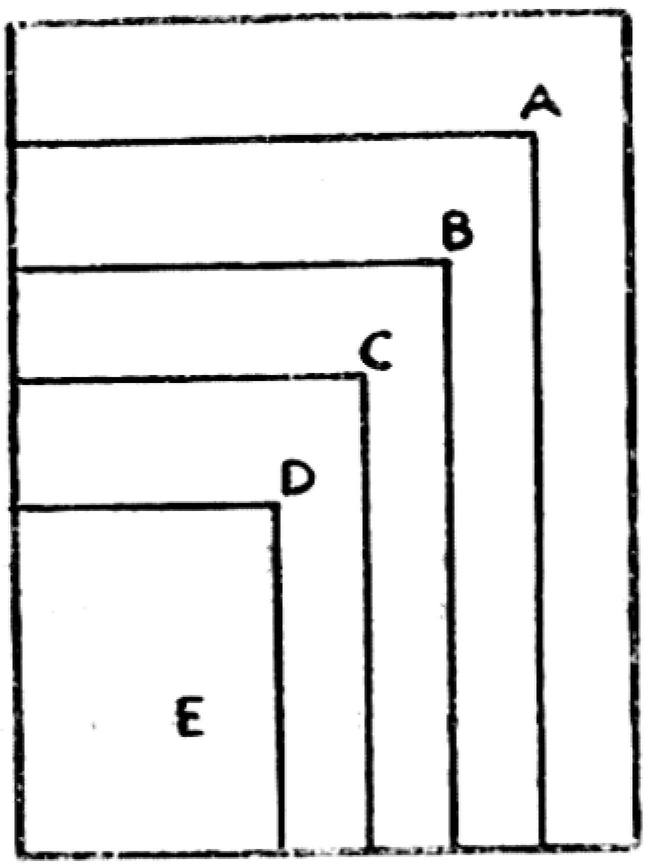

Fig. 43. By means of rectangles.

(6) The circle method or the *wheel diagram* is also an important method of showing comparative distribution. The circle denotes the total exports of India (Fig. 44) while the sectors represent individual items. A circle has 360° *i.e.* the total exports of India are equal to 360°. Now it is easy to reduce others to the proportions of 360°. This method gives the proportions and not actual amounts. It is, therefore, only useful to form a rough estimate at a glance.

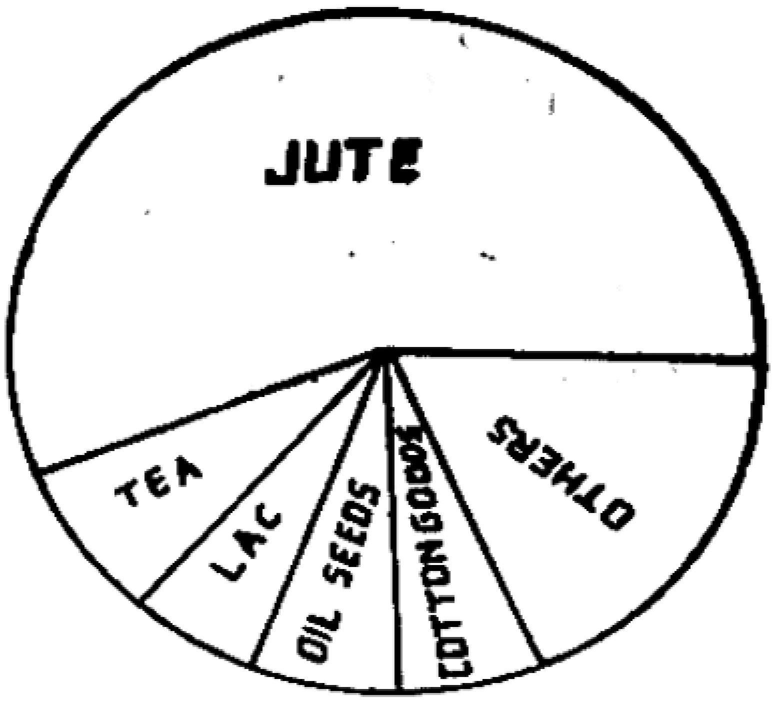

Fig. 44. Showing exports of India.

In Fig. 45 the circles vary in size. This has been done by selecting radii proportionate to the actual acreage under sugar-cane in every district.

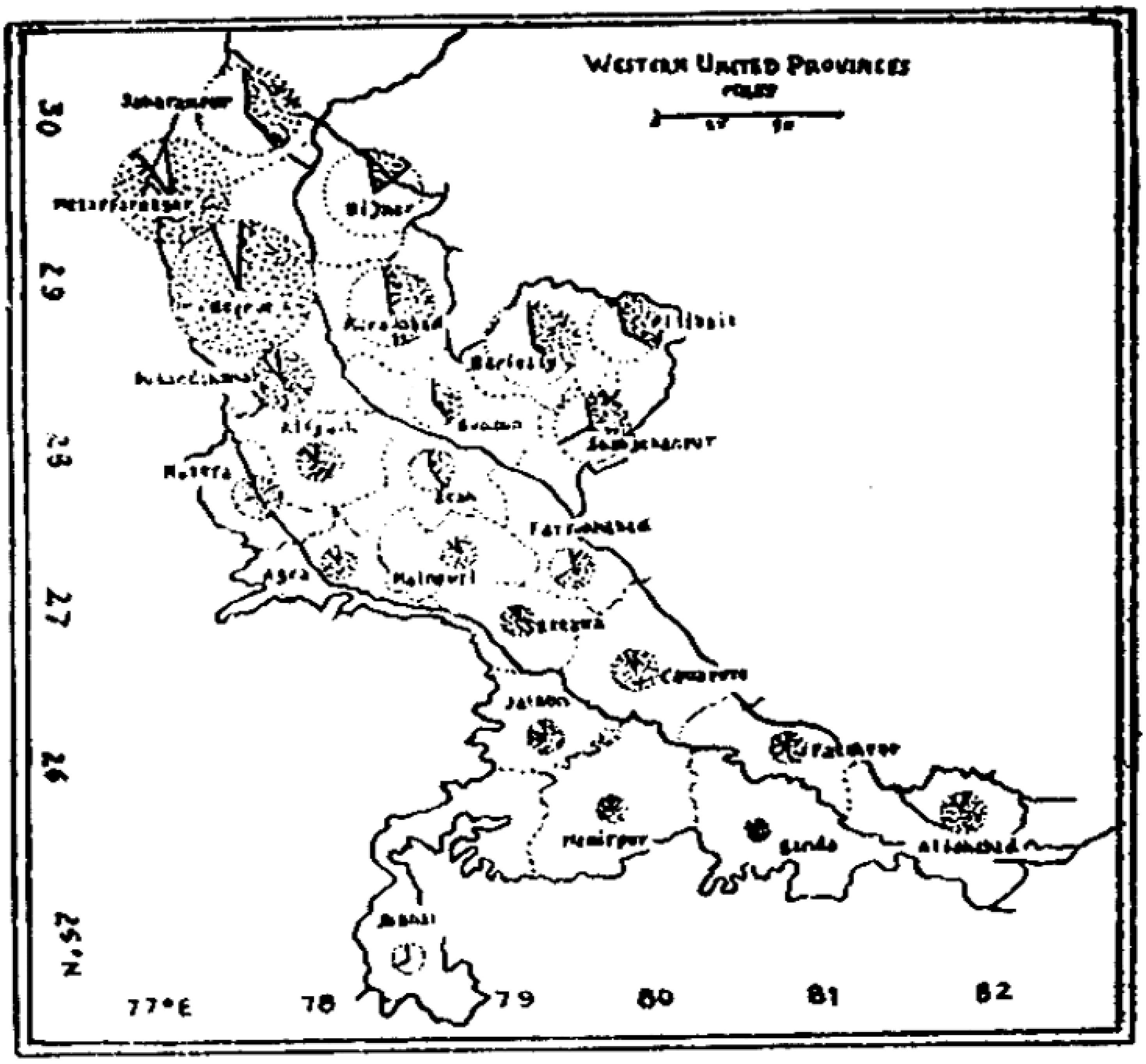

Fig. 45. The full circles denote total sugar-cane acreage and the dotted portions show irrigated sugar-cane.

PART III

ECONOMIC AND HUMAN GEOGRAPHY

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CHAPTER I

AGRICULTURE

Agriculture is the primary occupation (or industry) of man. He has been following it from times immemorial because it is the soil that supplies him with food and clothing. The nature of agriculture and the types of crops differ according to the physical euvironment (relief, climate and vegetation). Technically speaking farming may be of the following types :—

1. *Humid Farming* simply means farming or raising of crops with the help of rainfall without the help of artificial irrigation. This is possible in regions of comparatively heavier rainfalls mostly in areas getting more than 40 or 35 inches of rainfall per year. It is also essential that the rainfall be fairly evenly distributed during the year (*e.g.*, in Bengal).

2. *Irrigation Farming* means raising of crops with the help of artificial irrigation in regions of low and uncertain rainfalls.

3. *Dry Farming* is the latest innovation in agricultural technique and signifies the best use of rainfall in comparatively drier areas. The land is left fallow for some time and is ploughed and harrowed after every rainfall. It is always the endeavour of the farmer to reduce evaporation to the minimum and thus store all possible rain-water in the soil. Care of weeds and occasional harrowings form an essential parts of Dry Farming technique. This technique is to-day followed widely in the drier parts of U. S. A. and is also present in some of the drier regions of the old world.

4. *Plantation agriculture* means a sort of specialised agriculture carried out in tropical colonies in regions where hitherto agriculture was totally absent, *e.g.*, in the Tropical Forest regions and mountain slopes. The following characteristics distinguish it from primitive agriculture in those regions.[1]

(*a*) Large-scale operations—'large-scale' solely meaning that the area per unit holding is large.

---

[1] As given by Dr. Buchanan in 'A note on labour requirements in plantation agriculture.'—Geography, September, 1938.

(*b*) The direct employment of a labour force that is large, even in proportion to the large area that is being worked.

(*c*) Specialisation of one crop per holding (mostly cash crops).

(*d*) Production primarily meant for export.

(*e*) Production of crops that require planting and not merely sowing.

(*f*) Financial and executive control of the holding in the hands of foreigners, *i.e.*, commonly speaking.

The above-mentioned varieties of agriculture are based on technical characteristics. There is another set of agricultural systems based primarily on economic, cultural and to some extent, climatic conditions.

(*a*) *Self-sufficient agriculture* is carrier out, as is natural, in regions which are isolated and where transport is poor or even totally absent. Under these conditions an agricultural system must be evolved which may be able to supply the bare necessities of life in that region. It goes without saying that only a very low standard of living can be maintained. In Central Asia a vast number of farmers are self-sufficient. With improvements in transport, however, this system tends to break.

(*b*) *One-crop agriculture* is comparatively of very recent introduction. It is only possible to specialise in one crop if the means of communications and transport are efficient and quick as in U. S. A. where the farmers of the Cotton Belt specialize only in cotton. A system of free trade is also essential because the system involves a quick exchange of commodities. The advantages and disadvantages of one-crop agriculture may be summarized as below :—

Advantages

(1) Specialization with consequent development in quality, is possible.
(2) It is geographically and economically most sound in a free world.

Disadvantages

(1) The system loses its importance in a world of inefficient transport and restricted trade.
(2) Demand for that particular commodity may decrease owing to change in fashions or if any other competitors come in the market.
(3) Failure of the crop due to disease or climatic indifferences may prove disastrous to the farmer.
(4) Continual growing of one crop may wear out the soil.

(5) Labour and machinery remain idle in off season.

(c) *Extensive agriculture* is carried on in places where a lot of land is available and the population is small as in Canada. Under this system a wide use of agricultural machinery is essential. The expenses as well as the yields per acre ore small. Most one-crop farming is carried on by this system. Crops like cotton are not possible to grow under this system as they require a sort of specialised treatment at all stages of production.

(d) *Intensive agriculture* is characteristic of areas where only limited ground is available and the population is large. The idea is to get maximum value from the available land, *e.g.*, in China, Java and Belgium. Fruit-growing and market-gardening are the chief components of this type. Huge labour and capital have to be applied to relatively small areas of land under this system in order to get maximum value.

(e) *Mixed or Diversified* agriculture is just the opposite of one-crop agriculture. Under this system the farmer uses his land for a variety of purposes ; no specialization is possible. The failure of some single crop does not affect the farmer much because he hopes to make good his loss elsewhere. A regular though moderate income is assured. There is no idle time for labour or machinery. Crop rotation is possible. It, however, goes without saying that a farmer who follows this system of agriculture must have a vast agricultural knowledge and must be living near markets where all of his products may be in demand.

Varieties of crops :—Crops may be classified as under :—

(a) *Food crops* mean crops that are primarily cultivated for providing food to the nation, and, therefore, they form the most important part of a nation's economy and consequently they occupy a major portion of a country's arable land. The chief food crops are wheat, rice, sugar (beet and canc), barley, maize (or corn), millets, oats, rye, tea, coffee, cocoa, tobacco, fruits and spices.

(b) *Cash, money or industrial* crops include items like cotton and jute that the farmer grows for commercial purposes. They, therefore, occupy only the second position. Their acreage fluctuates from year to year according to the demand, and the farmer has to be very cautious about their production because quantities left over because of over-production or bad quality mean a great financial loss. Cash crops include fibres like cotton, jute, flax, hemp, silk and items like rubber and oil seeds.

CHAPTER II

FOOD CROPS

Wheat

Wheat is essentially a crop of Temperate climates. It was used even in prehistorical times. Its soil and climatic requirements are simple. It relishes soils where clay predominates. The soil should have a finer and smoother surface ; hence it is a crop of alluvial lands. It is better if the soil is renewed by floods. The temperature requirements are unique. In the beginning and middle of the growing periods rather low temperature is required and during the ripening period, high temperatures are better. That is why it ripens in India in March and April. It cannot stand too much cold and frost. It requires moisture for the soil a little before sowing. It is because of the temperature requirements that wheat is not grown at the same time in all the parts of the world. Near the harvesting time people have to wait if the weather is cloudy or cold. Different countries have their harvesting period in different months as shown below.[1]

January : Australia, New Zealand, Argentine, Chile.

Last week of February : India.

March : India and Upper Egypt.

April : India (Continued in full progress), Mexico, Cuba, Lower Egypt, Syria, Persia and Asia Minor.

May : Morocco, Algeria, Tunis, N. Asia Minor, China, Japan, Texas, Florida in U.S.A.

June : S. France, Mediterranean Peninsulas, Central and Eastern U.S.A., (South of 40° N.), Afghanistan, Japan.

July : N. France, Hungary, Rumania, Ukrain, Northern U.S.A., Ontario and Quebec.

August : England, Belgium, Netherlands, Germany, E. Canada.

September : Scotland, Sweden, Norway and Russia.
October : Finland, N. Russia.
November : Peru and S. Africa.
December : Burma and S. Australia.

***As given by Chisholm.**

Europe is the most important wheat producing continent. It produces about $\frac{1}{2}$ of the world total but consumes $\frac{5}{8}$, so it has to import. Hungary, Rumania and Western countries are most important for wheat. Wheat is also important in all the Mediterranean lands. For the last 15 years Germany is also trying to produce wheat on a large scale.

The continent next in importance is North America. In the prairies it is a spring crop because of the latitudes. But in southern U.S.A. it is a winter crop ; California also produces some wheat.

In Asia wheat is a temperate zone crop and is grown out of the Tropics in India, N. China, Manchuria and Russian Steppes along with the Western Asiatic Countries.

In South America it is important in the region of the river Plate. La Plata basin is second to the American Prairies. In Chile some wheat is grown with the help of irrigation.

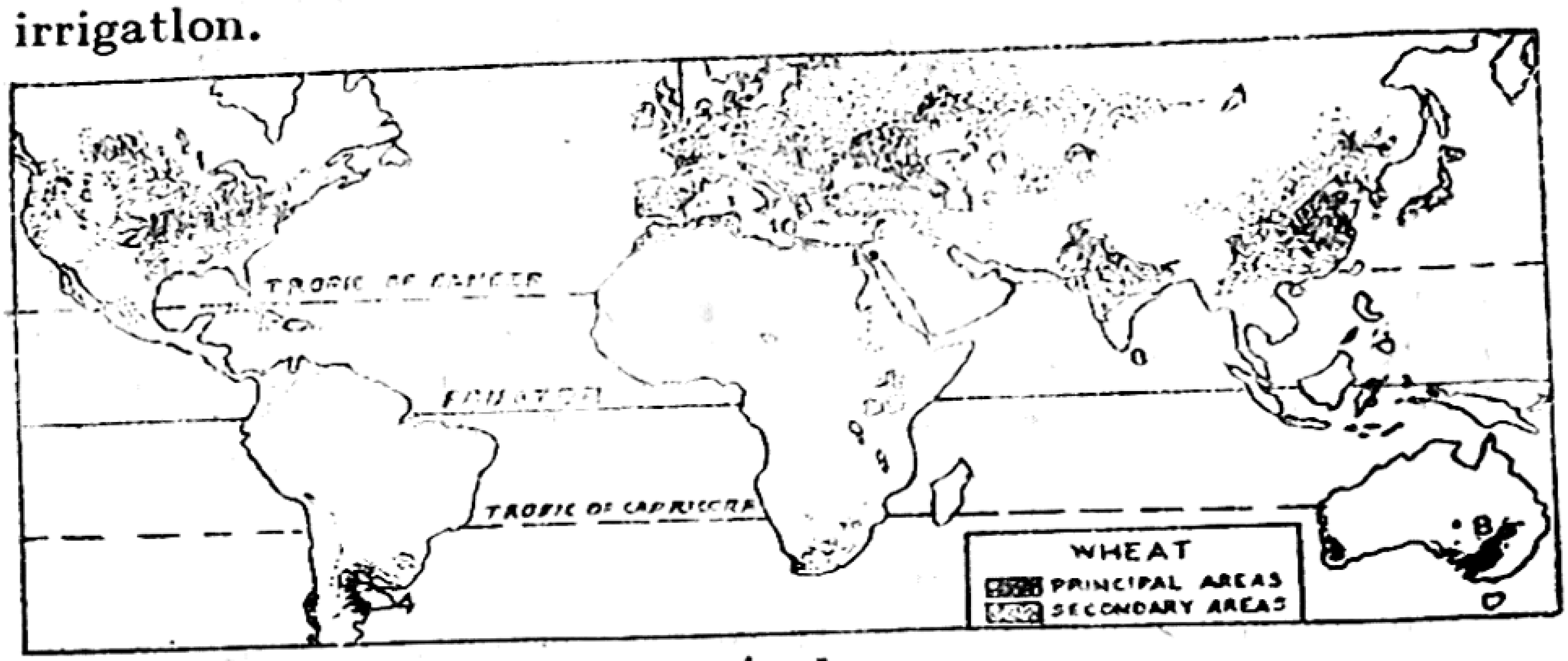

Fig. 1.

In Australia wheat is grown in Murray-Darling basin, in south coast round about Adelaide, and in S. W. region round about Perth and Fermentle. New Zealand is also an important wheat producing country.

In Africa wheat is not so important but some is grown in Southern Mediterranean lands, portions of Egypt and in Abbysinia.

The following tables are useful :—

I

Wheat Production of the world in millions of bushels (1935—38 average).

U. S. S. R.	1100	Canada	250
U.S.A.	650	Germany	225
India	350	Australia	150
France	290	Spain	150
Italy	280		

II

Yields per acre in Bushels

Holland	45	Italy	21
Denmark	43	Canada	19
U. K.	33	U.S.A.	15
Germany	33	Argentine	13
New Zealand	30	U.S.S.R.	12
France	24	India	10

Trade in Wheat.—Europe is the greatest importer of wheat amongst continents and claims about 70 per cent. of the total imported wheat. United Kingdom is the greatest wheat importing country and claims about 200 millions of bushels every year. The following table gives import percentages :—

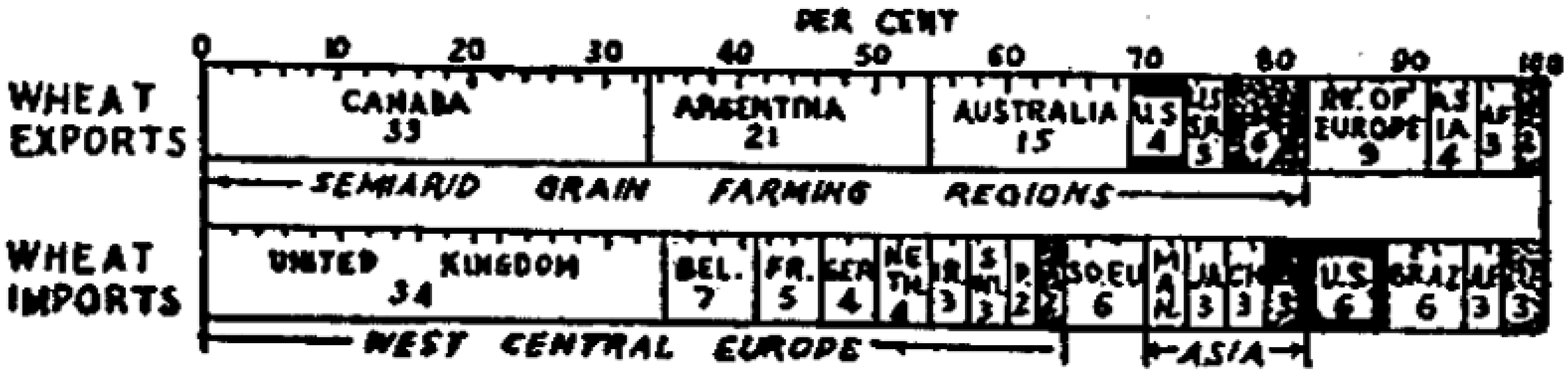

Fig. 2.

U. K.	34	p. c.	Netherlands	9	p. c.
Belgium	7	,,	Southern Europe	6	,,
Brazil	6	,,			
France	5	,,			
Germany	4	,,			

In the matter of export trade in wheat, Canada with its 185 millions of bushels per year, claims the first position. The next places are occupied by Argentine and Australia with their 130 and 100 millions of bushels per year respectively. U.S.A., Rumania, U.S.S.R. and Hungary also export some wheat.

Rice

Rice is a crop of South East Asia. It requires an abundant rainfall and high temperatures. It is important in regions getting above 40″ of rainfall per year.

It relishes clayey soils of the deltas. If there is shortage of rainfall, irrigation is required. In its earlier stages it requires about 2″ of rainfall but when it is young from 8″ to 10″ are required. During the flood days plant growth is very rapid. In Assam and Japan rice is also grown on hill terraces and is known as *upland rice.* Rice needs much labour.

Transplanting. Rice is first sown in well-manured, properly prepared nurseries, and then planted in open fields, when it has grown a little.

Broadcast Sowing. Seeds are thrown (Broadcast) like other crops in prepared fields.

Rice is grown to the exclusion of other crops and as many as 4 crops may be raised from the same field during the year (generally 2—3). Rice is produced in the most thickly populated countries of the world. No crop feeds such vast numbers as rice.

Total world acreage is estimated at 130 million acres per year.

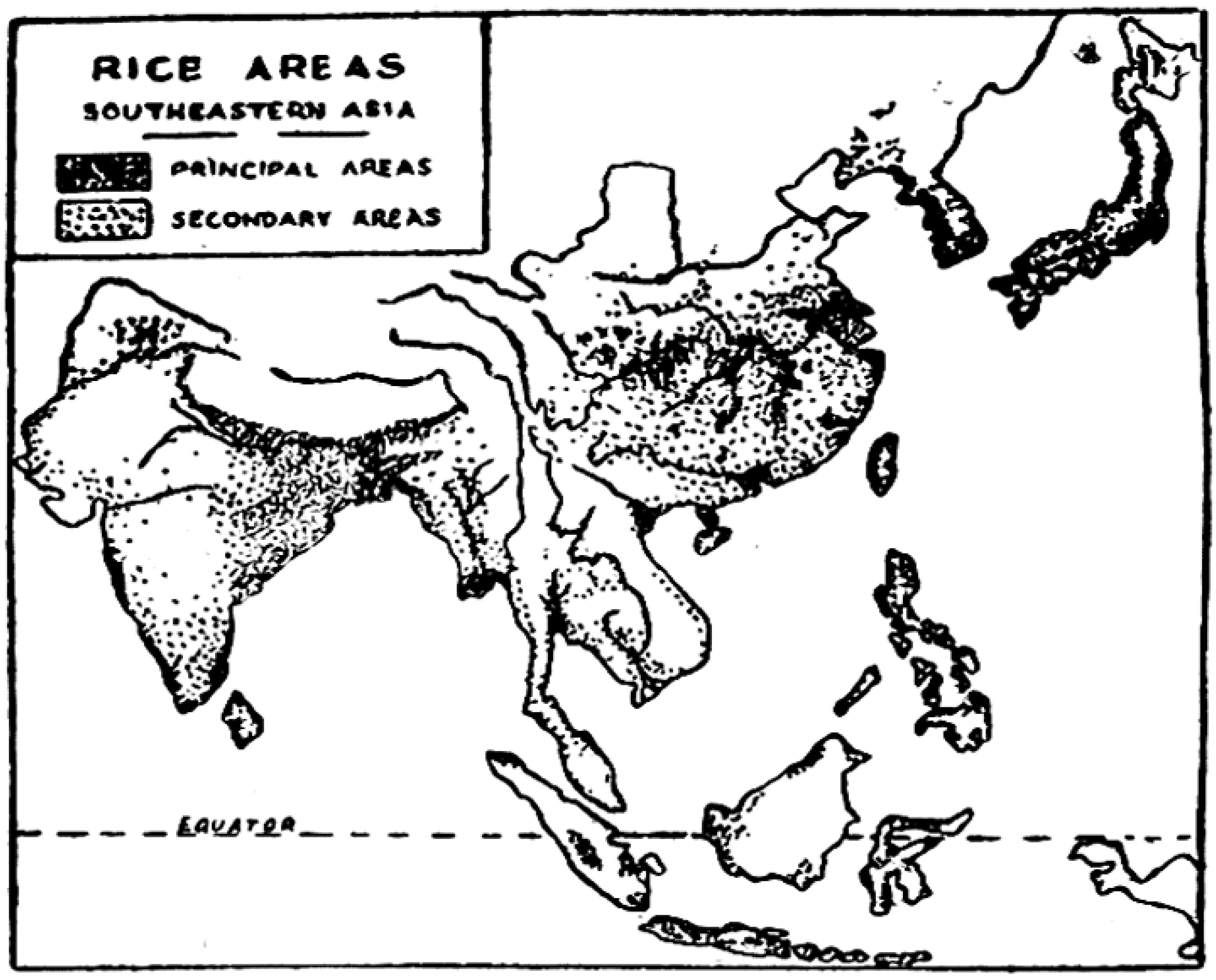

Fig. 3.

Rice is indigenous to S. E. Asia. China and India are the greatest producers of rice. In China rice is cultivated in Southern and South-eastern portions, in Yaung Tse valley and in portions of Central China where rainfall is more than 30″. In Japan upland rice is also grown. Burma produces 7,000,000 tons of rice every year. Here rice is cultivated mostly in the river valleys, coastal plains, and river deltas. In normal times most of the crop was exported to India. The European countries import low quality rice for the purpose of making starch.

India produces 36 per cent. of the world outturn of rice.

Now early maturing varieties are being introduced here to avoid disastrous results if the rainfall ceases earlier. Italy, Egypt and U.S.A. also produce some rice.

India's total outturn every year is about 82 million tons, the average per acre being 836 lbs. In other countries average yield per acre is more (In Japan 2350 lbs., Po Basin 3000 lbs., S.E. U.S.A. 1481 lbs. and Egypt 2079 lbs).

Trade. There is very little inter-national trade in rice as the countries that produce rice have little to spare because of their large populations. Burma, Indo-China and Thailand (Siam) are perhaps the greatest exporters of rice while Malaya (British), Dutch East Indies, France and Ceylon are the greatest importers. India gets all of its imports from Burma, and Ceylon gets some from India. Malaya and the East Indies require rice imports to feed plantation labourers.

Sugar

The most important sources of sugar are two *i.e.*, Beet and Sugar-cane. There are other sources also but from them it cannot be commercially produced.

Sugar which in the last three centuries was a luxury in Europe, has now come to be a necessity. Whereas in the 17th, and 18th Centuries 50,000 tons was the annual consumption, to-day it represents only three days' comsumption.

The present total production of sugar is more than 25 million metric tons out of which three fifths is cane-sugar and the rest *i.e.*, two fifths is Beet Sugar.

Sugar Beet:—Beet sugar to-day forms about 20 per cent of the total produced. It is most important in Germany and U.S.S.R. where it was first made. Up to the Great War it was very popular in Great Britain and other European countries, contributing about 46 per cent to the worlds total production. But with the development of sugarcane plantations in the newly-acquired colonies, it has lost a good portion of its importance.

Most of the Beet Sugar today comes from Central Europe and West Central U.S.A.

The total Sugar-Beet production of the world is about 650 million quintals.

Beet grows best in moist and mild climates where the mean summer temperature is about 70"F. Fairly heavy soils are most suited of the production of beet because of their moisture retaining qualities. Fertilizers are used to get high yields per acre.

In Europe U.S.S.R. with its 163 million quintals ranks foremost. Germany with over 105 million quintals is not far behind although it has recently lost its first position. France, U.K., and Italy also produce Sugar-beet in varying quantities.

U.S.A. claims a total of about 75 million quintals of Sugar-Beet. The chief Beet-producing areas there, are Colorado, Utah, Wyoming and California mostly foreign[1] labour is used in beet fields and U.S.A. grows enough for its local needs. It is only outranked by U.S.S.R. and Germany.

Sugar-cane. Because of its cheapness, and high sucrose content of its juice (75 per cent) the cane has grown in importance, so much so that to-day it is the principal source of sugar. Its chief requirements are (1) Steady high temperatures (75°—80°F), and abundant rainfall (60″). If the rainfall is insufficient, the deficiency must be made up by irrigation. The plant cannot stand frost. Sunshine is very important especially in its ripening period. It requires a good deal of labour. As all these conditions can be best fulfilled only in the tropics hence it is confined to these regions.

India, although the greatest producer, is also a great consumer, and has not much to export. Cuba is the biggest exporter, Hawaii which comes second exports only 9 lakh tons annually. Sugar from both these countries is exempted from custom duty in U.S.A. and this has led to the development of plantations in them. The other less important exporters are Brazil, Australia and Java.

The requirements of cultivation are only geographical and economical. It cannot stand frost and requires high temperatures 75°-80°F. It requires 60″ of rainfall or its equivalent in irrigation. Good sunshine is necessary in its ripening stage. Its cultivation needs cheap, abundant labour and because all these things are mostly found in tropics we may say that sugar-cane is primarily a crop of the tropical reigons. India is the most important grower and next comes Cuba. The yield per acre in Cuba is high, about 2570 lbs. Cuba supplies 1/5th of the world's export of sugar. Hawaii produces about 900,000 tons of sugar every year. Brazil, Australia and Java also produce considerable quantities of cane sugar. Sugar cane cultivation has greatly developed in recent years in India. In **1929-30,** 2,500,000, acres were under sugar-cane and in **1935-36,** 4,000,000 acres. The greatest expansion is in the provinces of U.P. and Bihar. They together produce 60 per cent. C.P. and Orissa claim about 10 per cent.

The yield per acre of finished cane-sugar in the different countries is Japan 50 tons, Mauritius 20 tons, and India 11 tons.

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[1] **Chiefly Mexican Labour.**

The main importers of sugar are U.S.A. (39 per cent.), U. K. (20 per cent.), Japan (9 per cent.), France (4 per cent) and China (8 per cent).

Maize

Maize or Indian corn is indigenous to America where it has been cultivated since pre-historic times and has been the staple food of the natives there. It requires no special technique to grow and its yields are usually very high. Although to-day it has lost much of its importance as a human food, it is in wide use in distilleries and large quantities of starch and glucose are manufactured from it. In U.S.A. and also in Europe, it is largely used as pig-food. Pigs seem to thrive very well on it.

Its soil requirements are simple enough and it can thrive on any fairly rich and easily drained soil. Maize is usually grown as a part of crop rotation which maintains the fertility of the soil.

Climate plays quite an important role in its geographical distribution. Put in a nut-shell, maize requires a long, hot summer, with fairly heavy summer rains (20″ and above), and abundant sun-shine specially during the ripening season. Its growing season spreads over a hundred and fifty days but its requirements have been appreciably modified by the breeding of early-maturing varieties that take about 90 days to be ready for harvesting.

U.S.A. with its 2,000 millions of bushels per year claim about 60 per cent. of the world total. In U.S.A. corn or maize claims an acreage larger than any other crop. Its cultivation is widespread but the corn belt situated in the eastern half of U.S.A. is the most important area for the production of Maize not only in U.S.A. but in the whole world. The corn belt includes roughly the states of Ohio, Indiana, illinois, Iowa, Kansas, Nebraska and Missouri.

Argentine with its 275 millions of Bushels is a distant second. China (225 millions of Bushels), Brazil (215 millions of Bushels), Rumania (200 millions of Bushels), U.S.S.R. (190 millions of Bushels) and India (100 millions of Bushels) are some of the other maize producing countries.

Although the production of maize is larger than that of wheat, not much of it finds its way into the world markets as most of it is consumed locally. Argentine with its 230 million of bushels per year leads the world in the export of maize. Next in importance comes Rumania (25 million of Bushels), U.S.S.R. Yogoslavia (20 million of Bushels), South Africa (20 million of Bushels) and U.S.A. (about 5 million of Bushels). The chief importers are :—

U. Kingdom	185	Millions of Bushels
Germany	50	,, ,,
U.S.A.	40	,, ,,
Netherlands	37	,, ,,
France	29	,, ,,
Canada	15	,, ,,

Barley

Barley, also one of the early cultivated cereals, resembles wheat in appearance. It is a native of Western Asia and was perhaps the earliest crop to be cultivated there. It has no rigid requirements either in the matter of soil or in the matter of climate, and can grow on a variety of soils and in a variety of climates. It is a very widely spread crop and is grown in lands from within the very Tropics to those even beyond the Arctic circle (Norway, Sweden, Russia, Finland and Canada). It, however, grows best in Mediterranean climates.

In the Western hemisphere barley is chiefly grown for the manufacture of Beer and Whisky. It is also used as a bread grain by poor people and is a common food for cattle, pigs and horses.

The world production of Barley has been estimated at about 41 Million Metric tons 50 per cent. out of which is claimed by Europe (U.S.S.R. alone, claims about half). China is also a huge producer of Barley and its average production is estimated at about 8 million metric tons. U.S.A. is also quite important with its 6.5 millions of metric tons.

In the dry regions of the Tropical and Sub-Tropical climates of Northern Africa, India and Spain, barley grows instead of the wheat, because it requires less moisture.

The following table gives average yields of barley per acre.

Belgium	44.2	Bushels
Canada	28.9	,,
U.S.S.R.	21.8	,,
U.S.A.	14	,,

Trade in Barley is restricted to countries where Beer and Whisky is in much use because wheat has replaced it as human food in most of the European countries. As such United Kingdom and Germany are the greatest importers. Belgium, Netherlands and France also import some barley. The greatest exporters are Rumania, Argentine, U.S.S.R., and Canada. Most of the Canadian Barley finds its way into British markets.

Oats

Oats are closely allied to wheat. In the early stages of growth, they resemble wheat and barley. The plant usually grows to a height of 3 to 4 feet.

They grow well in a cool, moist climate and require no special type of soil. They can grow easily on poor soils when it is impossible to grow wheat and barley. They are sown in spring or early summer usually in rotation with wheat (winter) and are therefore, rare in areas of spring-wheat.

Oats are used as human food in cool, moist countries and elsewhere they form an important animal food and are used as a source of straw.

The average world production of Oats is about 64 million metric tons, out of which one fourth is claimed by U.S.S.R. The following table shows Oat production in various countries (1932—36 yearly averages):

U.S.S.R.	16.4	Million Metric Tons.
U.S.A.	13.1	,, ,, ,,
Germany	6.6	,, ,, ,,
Canada	5.2	,, ,, ,,
France	4.7	,, ,, ,,
U.K.	2.4	,, ,, ,,

Not much Oats find their way into international markets, the average total world trade being only about 1,000,000 Metric Tons. Canada and Argentine are the chief exporters, while the main importers are United Kingdom, Switzerland and U.S.A.

Rye

Rye too is closely related to wheat and barley and was cultivated for the first time in South-Eastern Europe. It can grow even on poor soils and in a variety of climates having no frost. Therefore it cannot thrive in northern latitudes. It is chiefly used for bread-making in regions where wheat is scarce. It is also cultivated as a fodder crop and for the manufacture of Vodka, whisky and other alcoholic drinks. The straw is used for the manufacture of a variety of articles like baskets, hats, etc.

The average total production of Rye is estimated at 46 millions of Metric Tons, out of which about half is claimed by U.S.S.R. (22 million Metric Tons). Sufficient quantities are also raised in Germany (7.6 Million Metric Tons) and Poland (6.4 Million Metric Tons). Outside Europe there is relatively small Rye production.

Rye is essentially grown for home consumption and very little enters world trade.

Millets

Millets include several hardy cereals grown in tropical climates. They can even thrine in hardy soils and dry climates. They are grown for fodder and also for food. They are specially characteristic of India and form the staple food of vast numbers in drier regions where rice is not possible to grow. In China, Japan and Sudan millets are also grown for human consumption. In U. S. A., millets are raised as fodder.

There is little or no trade in millets as most of it is consumed locally.

Tea

The tea plant is native to south-eastern Asia and is mainly grown on the wet mountain slopes. Cheap native labour seems to be the most important factor in more or less limiting tea-production to these regions. During the last hundred years or so tea has taken the shape of a commercial plantation crop and is largely imported to temperate latitudes where tea-drinking is greatly in vogue.

The tea plant (or better a bush) thrives well in warm, rainy areas having good drainage and with a fair amount of humus content in the soil. On account of its rigid drainage requirements, it is best grown on hill and mountain sides of the tropical and sub-tropical areas.

Labour is an important factor in tea cultivation as all picking and prunning is done by hand and as such oriental tea growers are at a great advantage when compared to those in U. S. A., Brazil, West Indies and elsewhere.

China is believed to be the greatest producer of tea but we can never be very true of her figures. India with its 415 milllon pounds per year, ranks second. Ceylon (220 million pounds), Netherlands India (165 million pounds), and Japan (115 million pounds), are some of the other chief tea-producing countries.

Though tea is grown on small farms in China and Japan and though much of it is locally consumed, tea is essentially a tropical plantation crop in India and Ceylon meant for consumption in temperate latitudes specially West Central Europe and U. S. A. The following table gives export figures of tea (1938):—

India	...	366	million	pounds
Ceylon	...	286	,,	,,
Java	...	127	,,	,,
China	...	79	,,	,,
Japan	...	89	,,	,,

In the matter of imports West Central Europe claims about 62 per cent of the world total and U. S. A. about 10 per cent. United Kingdom alone claims about half of the total tea imports of the world and the whole British Empire consumes about 75 per cent of the total tea imports. Tea is not much consumed in coffee-drinking area, *e. g.*, in U. S. A. where the annual per capita consumption of tea is only 3 pound while that of coffee is about 11·5 pounds.

The modern European-Controlled tea plantations of Assam, Ceylon and Java have obtained control of the world tea-trade. This has resulted in an important change in the tea-producing districts. India and Ceylon have more than doubled their exports since 1896, while Java now sends out more than four times its former exports. This has affected Chinese exports adversety where tea exports have dwindled to about ¼th.

Coffee

Coffee as a drink was first introduced in Arabia and then it found its way into Ceylon, Europe and Brazil. For more than 200 years Java and Ceylon had the monopoly of coffee production but to-day this control has shifted to Brazil, Central America and West Indies.

The coffee plant is an evergreen plant with shiny, smooth, oblong leaves. The average life of a coffee plant is about 6 to 7 years.

Coffee plants thrive in warm (70° to 80°F) and moist (50 to 100 inches) areas. During the early stages of its growth, coffee trees need shade. Most of the world coffee grows on the cool pleateaus of the tropical highlands specially in regions where volcanic soil predominates.

One coffee plant yields ½ to 2 pounds of coffee annually. Coffee beans are picked during the winter season, *e g.*, in Brazil the harvesting season lasts from April to October which is the winter season in the Southern Hemisphere.

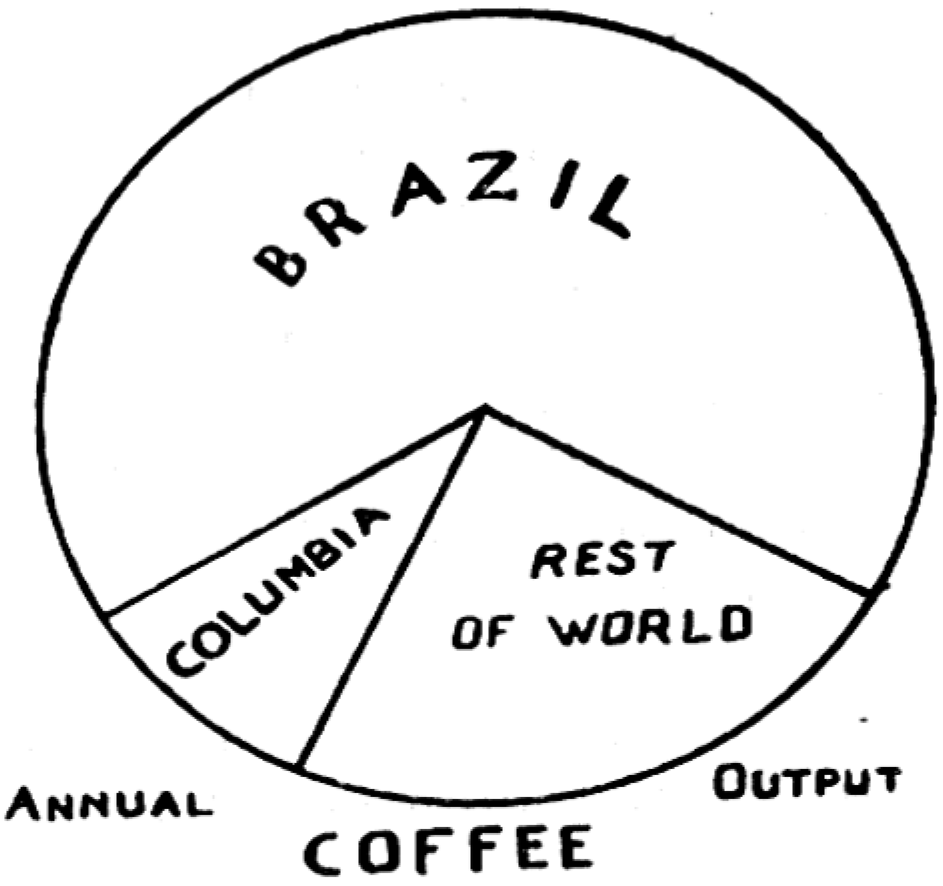

Fig. 4.

Brazil grows about ⅔ of the total coffee of the world. The mountains of Columbia are also important. The table given below shows the average total production for various countries.

Brazil	...	3,150	millions	of	pounds.
Columbia	...	600	,,	,,	,,
India	...	250	,,	,,	,,
Venezuela	...	150	,,	,,	,,
Mexico	...	100	,,	,,	,,
Cuba	...	100	,,	,,	,,
Haiti	...	80	,,	,,	,,

Trade in coffee is an extensive world business. Each year about 125,000 tons of coffee finds its way into the world markets. Nearly one half of the total exports are taken up by U. S. A., where people take a lot of coffee. West Central Europe specially France (12 p. c.), Germany (11 p. c.) takes about 33 p. c. Great Britain does not consume much coffee as people there are more addicted to tea and drink only about 2 lbs of coffee per head per year as compared to 42 lbs of tea.

Brazil exports nearly all her coffee crops and supplies more than half of the world's requirements. Percentages for the export of coffee are given below :—

	Brazil	...	55	p. c. of total world exports
	Columbia	...	13	,,
	Africa	...	8	,,
Caribbean America	Venezuela	...	3	,,
	Salvador	...	3	,,
	Gantemala	...	3	,,

Cocoa

Cocoa is derived from a tree which is native to Tropical America. The cocoa tree needs a warm, damp climate, with good rich soil and shelter from direct exposure to hot sunshine and winds. In this connection Rubber trees are grown among cocoa plantations to afford shade. Comparatively cocoa requires little labour and so can be cultivated in West Africa and Tropical America. It is essentially a plant of the tropics.

Gold Coast leads in cocoa production with its 570 million pounds per year. Brazil with its 275 million pounds is also important. The table gives figures for some other cocoa-producing countries:—

Nigeria	200	million pounds.
Ivory Coast	110	,,
French Cameroons	50	,,
Ecuador	50	,,
Venezuela	45	,,

U S. A. is the greatest consumer of cocoa and then come Germany, United Kingdom, Netherland and France.

Gold Coast, Nigeria and Brazil are the topmost exporters of cocoa.

Cocoa Imports			*Cocoa Exports*		
U.S. A.	38	per cent	Gold coast	41	per cent.
Germany	15	,,	Brazil	17	,,
U. K.	14	,,	Nigeria	12	,,
Netherland	9	,,	Ivory coast	7	,,
France	7	,,	Ecuador	3	,,

Tobacco

Tobacco is prepared from the leaves of plants which belong to Tropical America. Though the use of Tobacco is centuries old, its greatest consumption has been in modern times. Its use has now spread throughout the world. Although tobacco plant is essentially a tropical plant, it is now grown in all the parts of the world except of course the hot and cold deserts.

Tobacco is very sensitive to changes in weather and soil differences in both of these factors affect the quality of the product. It thrives in warm moist humid tropical and sub-tropical climates and relishes fertile and well-drained sandy soils. It is injured by frost.

Tobacco seeds are germinated in nursery beds and the seedlings are transplanted mainly by hand. The cultivation and production of tobacco generally requires a considerable amount of labour but the dried tobacco leaves are usually sent to the countries of demand just as they are, unmanufactured.

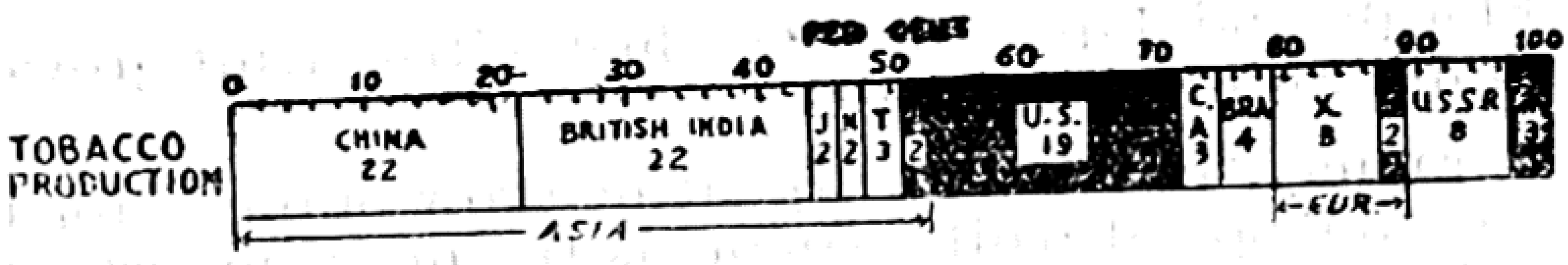

Fig. 5.

India, China, and the U. S. A., each produce near about more than one-fifth of the world's tobacco. U. S. S. R., Hungry, Brazil and Greece are some of the other tobacco producing countries. Among the continents Asia leads in the production of tobacco and claims about 55 per cent of the total production. The following table shows figures of tobacco production in various countries :—

India	...	1,500	millions of pounds.
China	...	1,375	,, ,,
U. S. A.	...	1,175	,, ,,
U. S. S. R.	...	500	,, ,,
Brazil	...	209	,, ,,
Japan	..	175	,, ,,
Turkey	...	100	,, ,,

The United States export about half of their total production, while India and China inspite of their huge production export very little. West Central Europe takes more than two thirds of the world's imports of raw tobacco. The United Kingdom (21 per cent) buys chiefly from U. S. A. whereas Germany takes in its supplies from Turkey, Brazil and the Balkan states. U. S. A. imports special brands from Cuba, Sumatra and Southern Europe.

Fruits

Most of the fruits are raised near the markets since they cannot be taken to long distances owning to their perishable nature. They are not restricted to any one region and are grown all over the world. For commercial purposes, however, fruits of tropical and temperate regions are important. The cold storage methods and the introduction of faster means of transport have greatly helped in bringing fruits to a respectable position in inter-national trade.

Most fruits require considerable moisture, freedom from frosts and plenty of sun-shine for ripening. The need of a long growing season limits the poleward extension of fruit growing.

The humid sub-tropical region grows large quantities of citrus fruits that favourably compete with the same kinds of fruit grown in the dry summer sub-tropical region. The grape fruit is more important in the former.

Florida and Japan are the chief citrus-fruit growers of the humid Sub-tropical region.

Paraguay, Brazil and Argentine grow oranges for home use. Of all tropical fruits banana is the most important and is largely exported to the temperate regions. Bananas are grown chiefly in the West Indies, Central America, Tasmania, Costa Rica, Columbia and its chief importers are Europe and U. S. A.

Pine-apple is also an important tropical fruit and is chiefly grown in Str. Settlements, West Indies, Florida and Thailand (Siam).

Date is a desert and semi-desert fruit and is important in North Africa, Persia and North-West India and is largely exported to U. S. A. and Europe.

In the Mediterranean region olive, figs, grapes, apricots, oranges. lemons and almonds grow abundantly. Grapes are important in world commerce and are shipped fresh in cold storage. But the trade in juice, wine and raisins (dried grapes) is much more important.

Wine is fermented juice of grapes and is native to eastern Europe and Western Asia. Now it has been carried to all suitable climates. France and Italy are the greatest producers of wine. Spain, Austria, Hungry, Algeria, Portugal and Germany also produce considerable quantities. Besides the grape-wine, a considerable quantity of spurious wine of chemical preparation is also in the market.

Spices.

Most of the spices belong to the tropical and subtropical regions and are indigenous to India and the East Indies. Since very early days they have formed an important item of commerce. Spices are used for making our food more palatable and for the manufacture of certain oils and scents etc. In India spices are an important item of food.

A number of spice plantations are situated in tropical lands firstly because of the warm, moist climate and secondly because of the abundant cheap labour available there. Plantations usually specialise in one or two spices.

مرچ

Most of the world's pepper comes from the East Indies specially Java, Sumatra, Malaya and Borneo and the Malabar coast of India.

لونگ

Cloves which are used in the preparation of food, oils and scents are produced chiefly in Zanzibar (East Africa). In India cloves are cultivated in the Madras Presidency.

سونٹھ

Ginger is indigenous to Asia and most of its supplies come from India, China and Jamaica. دار چینی

الائچی

Other tropical spices are chillies, cinnamon, vanilla and cardamoms.

A few spices like mustard, sage and thyme are had from the temperate regions of Europe. Soya sauce is made from Soya Beans grown in China and Japan.

CHAPTER III

(INDUSTRIAL CROPS)

Cotton

Cotton is the most important industrial crop (fibre) of a sub-tropical climate and its importance dates back to the very earliest times. Cotton farming was in a healthy state in India and China even in pre-historic times. In America there is evidence to believe, that cotton was grown even at the time of early explorations, exactly in the same spots where it is important to-day. To-day it is the most widely used fibre and grows in the tropical and sub-tropical regions but it reaches its best standard in the latter region. In America its expansion was stimulated by the invention of the ginning machine in 1793. In U. S. A. its northern limit is 37° N, but in Asia and Europe it is cultivated even upto 41° N latitude.

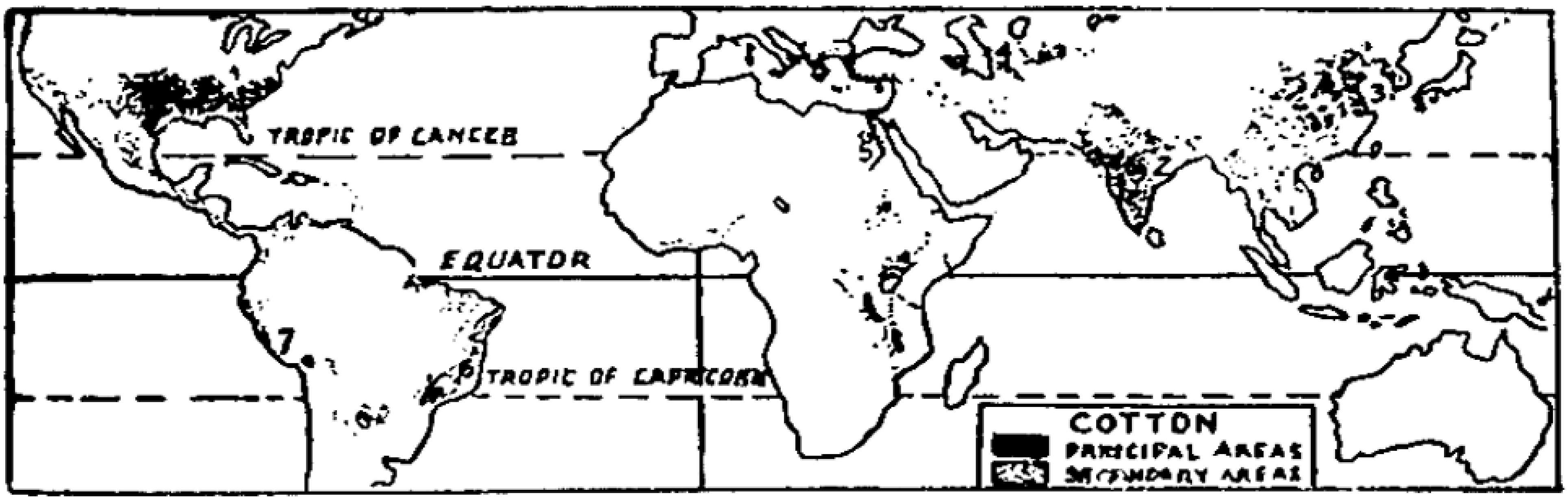

Fig. 6.

U. S. A. is the most important producer of cotton and is followed by India, China, Egypt and Brazil. No accurate figures are available for China ; whole of the crop there is exhausted locally and there are no exports of the commodity except some to Japan. In Great Britain the imports increased by leaps and bounds between the year 1790 and 1890. During this century the imports increased by 2,000 per cent. U. S. A. produces enough cotton for her home consumption and has sufficient surplus for export. Her exports of cotton every year are worth 100,000,000 dollars.

Climate plays the most important role in its cultivation and consequently in its geographical distribution also. It can stand neither very high nor very low temperatures. Frost is its deadliest enemy, and for good cultivation cotton needs about 7 months of good, frost free weather. The lowest temperatures it can stand is 77° F, beyond wnich its production becomes uncommercial. Its cultivation, therefore, is restricted to 41° N and 30° S latitudes and it may be called a crop indigenous to the sub-tropical belt. Very high temperatures are equally harmful and as such the interoir of the tropics are not very suited to its cultivation.

Cotton requires sufficient rainfall but strong showers may harm the young plants ; it is, therefore sown a bit before the rains so that by the time rains start, the plant may be strong enough to face the torrents. In the drier regions, artificial irrigation may be resorted to. In India its cultivation is restricted to regions getting 20″-40″ of yearly rainfall.

Its soil requirements are not very rigid and it can easily grow on any fertile soil if proper manuring is regularly resorted to. Lava soils, limestone soils and rich sandy soils are, however, its favourites. In India the black cotton-soil region and in U. S. A. the black Prairie soils and the alluvial soils of the Mississipi valley are best suited for its production.

Cotton cultivation needs an abundant supply of cheap, skilled labour specially at the picking stage which is best done by hand. In the eastern countries of Egypt, India and China, labour is abundant but in U. S. A. not much of cheap, native labour is to be had and in order to meet this demand African natives had to be imported to work as slaves in the cotton fields. This feature, however, exists no more as slavery has been abolished.

The quality of the cotton depends on (*a*) length of the staple—longer the finer, (*b*) fineness, lustre and softness of the lint and (*c*) the strength and colour of each fibre.

There are many varieties of cotton and the value and utility of each depends upon the length, fineness and colour of the fibre or staple. From the original species, many new scientific varieties have been evolved, the best of which is the sea-Island cotton. It was first grown in Georgia and South Corolina in U. S. A. The average length of its fibre is two inches and this variety surpasses all others in quality. It has now been successfully introduced in Egypt and India. Egyptian cotton is also of a very fine quality, but it has not yet been very successfully introduced outside Egypt.

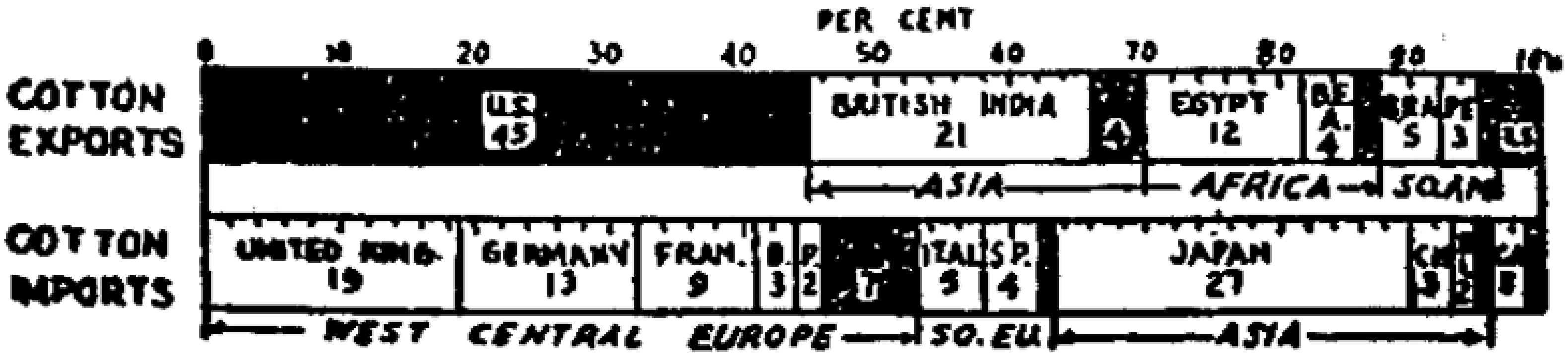

Fig. 7.

U. S. A. ranks first, producing half of the world cotton. It is grown in South-East U. S. A. and in the cotton belt in the East. It is a summer crop grown in March and April and picked in October and November.

In America the cotton belt, controlled by the temperature and rainfall has the 37° N Lat. and 99° W longitude as its Northern and Western limits respectively. It grows best in Black Prairie soils and in the alluvial soils of the Mississipi Valley. U. S. A. is the biggest producer of cotton in the world, contributing more than half of the total output. Cotton, is also grown in small areas in California Valley with the help of irrigation, and also in other areas, besides the great cotton belt in the South East. At present about 50,000 square miles are under cotton, although experts suggest that 7 lakh sq. miles can be cultivated. Here it is sown in March and April and is picked in October or November. Production in U. S. A. has made great progress during the last 25 years as may be evident from the following figures :—

1909—13 ... 10,560 million lbs. of cotton per year.
1936—38 ... 15,719 „ „ „ „

The average yield per acre is 180 lbs., although 225 lbs. per acre have also been recorded, and the lowest yields are nearly 170 lbs. per acre.

The yield is about half the average yield of an Egyptian acre. Even U. S. S. R. which is not very important, produce $\frac{2}{3}$ times more cotton than the U. S. from one acre.

China.—In China cotton is confined to the Yangtse and Hwangho basins and the deltas of other rivers. The tools and the processes of agriculture are primitive, and not much cotton is available for export. Accurate figures about chinese production are not available.

Peru.—Cotton here is grown in irrigated areas only. Peru has the advantage of getting cheap manures from North Chile.

U. S. S. R.—Cotton area lies in Trans-Caucasia and

Turkistan. The output is rapidly increasing but the Union still imports large quantities.

Egypt.—Cotton is confined to the northern areas irrigated by the Nile. The average yield of 300 lbs. per acre is the highest in the world. Although only 4000 sqr. miles are under cotton, Egypt is famous for the fine quality and high yields per acre because the soil is good, there is ample sun-shine, the area is free of locust and pest, and the cultivators know how to water their fields.

The following table gives the actual production of cotton in various countries and also their percentage share of the world total :—

Countries	Cotton Production in millions of Bales (bale=478 pounds.)	Percentage of the world total (approximate)
U. S. A. ..	13 million bales ...	52 per cent.
India ...	5 ,, ,, ...	23 ,,
China including Manchuria.	3 ,, ,, ..	10 ,,
U. S. S. R.	2·75 ,, ,, ...	6 ,,
Egypt ...	2 ,, ,, ..	9 ,, including the rest of the world.
Brazil ...	2 ,, ,, ...	
Mexico ...	·5 ,, ,, ...	
Peru ...	·5 ,, ,, ...	

Trade—Cotton is also the most important trade commodity to-day. It is exported and imported both as raw and in the shape of manufactured cloth. Cotton goods are used nearly in all the places of the world. U. S. A., Egypt and India are the greatest exporters of cotton as figure No. 7 shows. Taken together they claim about 80 per cent of the total cotton exports of the world, the other exporting centres being British East Africa, Brazil and Peru.

The most important importers of cotton as shown in the diagram are United Kingdom, Japan, Germany, France and Canada.

Most of the other countries like U. S. S. R., Mexico, Central America and Argentine grow just sufficient for their own consumption.

Jute

Next to cotton, jute is the most important of all fibre crops. Nearly all of it is used for packing purposes in the shape of gunny bags and gunny cloth. It owes its importance as a packing material mainly due to its cheapness. But now-a-days paper bags are replacing gunny bags in U. S. A. and the Canadian prairies probably because these people want to be self sufficient in this respect also.

Jute is a tall plant about 12 ft. high and branches off at the top. This is a plant which belongs essentially to the tropics. Its greatest concentration is in east. Bengal and the valley of the Brahmputra. It needs abundant and cheap labour besides climatic and soil factors. It requires abundant water in all the stages of its growth. Big tanks of water of sufficient depth are constructed where bales and bales of plants are retted, *i.e.*, kept for a week or more until the outer bark and the inner fibre (6″—1 ft. long) can be separated.

The yields are very high averaging 13 tons of green jute or 1000—1200 lbs of finished fibre per acre (24 lbs of green jute yield about 1 lb. of finished fibre).

India has virtually a monopoly of jute. Out of 1·9 million acres under jute in India, 1·6 millions are in Bengal alone, the remaining. ·3 millions being distributed in Assam, Bihar and Orissa.

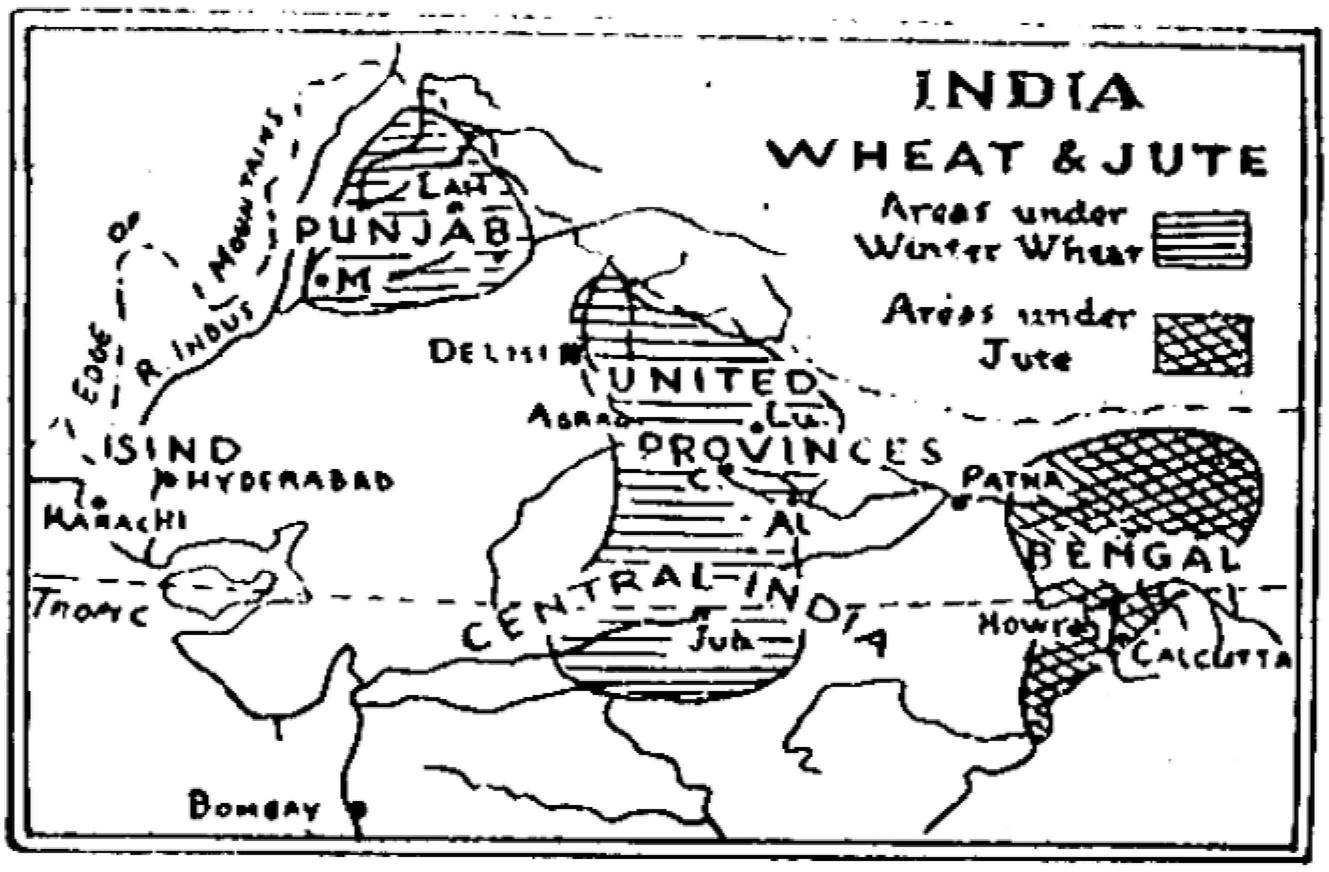

Fig. 8.

In Bengal the largest acreages are in Mymensingh, Dacca, Rangpur, Bogra and Pabna Districts, along the banks of the Brahmputra. Area under jute decreases towards the west.

In Orissa, Cuttack and in Assam, Brahmputra Valley and Sylhet are important. The District of Burnia grows 90% of Bitwar jute.

Annual production is as follows :—

Bengal 8,23,200 bales (of 400 lbs each), Bihar 7,19,000 bales, Assam 5,57,000 bales and Orrisa 47,000 bales.

Jute Industry.—The area North of Calcutta, along the banks of the Hooghly is the most important centre of jute manufacture in India ; the area round Chittagong being the next. Of the 103 mills in India 95 are situated in Bengal, 4 are in Madras, 3 in Orrisa and 1 in U. P. They manufacture about 6 lakh tons of gunny bags, 3·5 lakh tons of gunny cloth, 3,000 tons of rope and 1,000 tons of canvas. Before 1908 Dundee in Scotland used to be the centre of manufacture and raw jute was exported to Dundee for manufacture. Since then Calcutta has increasingly gained in importance. Most of the manufactured products are exported to U. Kingdom, Germany, U. S. A., France, Canada, Japan, Italy and Argentine.

Besides India, some jute is also grown in Ceylon, Formosa, China and Malaya.

In India there has been a tendency to over-produce which resulted in a drastic reduction in prices. The demand for Indian jute has also decreased owing to the introduction of certain substitutes. The area, therefore, is on the decrease and more and more rice and sugar-cane is being grown in those areas.

Silk

Silk is an animal fibre derived from the cocoons of the silk worms. Silk culture (Sericulture) is an intensive type of farming. A feed crop, mostly mulberry trees, is first produced and silk worms are fed on them. The fibre thus turned out by the worms is sent to the factories to be made into cloth.

Most of the world's silk comes from the monsoon regions specially China and Japan and besides climate and consideration for the growth of the mulberry tree, the availability of cheap, skilled labour is the chief factor that limits the production of silk. Owing to this consideration perhaps, the industry tends to concentrate in old, densely populated countries of the east. Most of the work in connection with sericulture is done by women and children. In many places in Japan and China silk is by far the cheapest and the most suitable cloth for hot weather use.

Sericulture originated in China in about 200 A. D. and soon spread to Japan, India, Western Asia and Europe. The new world also has small areas devoted to this industry. The greatest concentrations, however, are in eastern Asia and southern Europe.

In Japan western factory methods have been adopted and the greatest concentration is found in Central Honshu. U. S. A. is Japan's chief buyer of silk. Japan exports about

⅔rd of its silk supplies mainly to U. S. A. and claims about ¾th of world raw silk.

Next in importance to Japan come China and Italy. The plain of Lombardy in Italy has many silk centres, the chief of which is Milan.

The Rhone valley in France specially Lyons, is noted for its silk industries—production of both raw and manufactured silk.

China produces fair amounts of silk but one cannot make an exact estimate as reliable figures are not available. Some even believe that China is the greatest producer of silk. But one thing is certain that from the commercial point of view China is far behind. The middle Yangtse valley, the Canton Basin, Min valley and the Shantung Peninsula are the most important silk centres of China. The whole industry is carried on by old, crude methods as a cottage industry.

Certain small areas in Syria are also doing some silk business.

Rayon.—The first artificial silk fibre was produced in 1884 and it has gradually worked its way up to a respectable position and is now a serious rival of real silk. It is a chemical production and is ordinarily inferior to silk in quality. It is largely mixed with cotton, silk and wool. Its best asset is its cheapness.

Japan is the greatest rayon-manufacturing country to-day. Germany, U. S. A., Italy and Great Britain also produce good quantities of rayon. In Japan, Germany and Italy rayon is used as a substitute for cotton which has to be imported while rayon could be manufactured with locally available ingredients.

Hemp

Hemp is a coarse fibre and is used for strong fabrics like canvas and also for ropes. It is produced from the fibres of a tall, slender plant and has to be hand-pulled, retted and 'scutched.' Ordinary Hemp is a warm temperate crop and requires a moist and fairly rich soil. It has a short growing season that allows it to thrive even in the far north.

Manila Hemp is an important variety of hemp and gets its name from Manila, a port in the Phillipines, through which most of the product is exported. This particular variety is almost confined to the lava soils of the Phillipines where ⅛th of the total arable land is devoted to its cultivation. The annual production of Manila hemp is reported to be about 200,000 tons, most of which is exported to U. S. A. for manufacturing purposes. Some hemp is also grown in China, Italy, U. S. S. R. and U. S. A.

Sisal Hemp is another important variety and is more or less the absolute monopoly of Mexico. It is also grown in Yucatan, the West Indies and Hawaii. It is mostly exported to U. S. A. and United Kingdom.

Flax

The flax plant grows widely in temperate regions and also in warm, damp climates ; the only difference being that in temperate climates the plant develops fibre, while in warm, damp climates, it runs into seed. The fibre is used for making linen. The seeds or linseed are used for the manufacture of linseed oil.

Flax for linen is widely produced in north western Europe, U. S. S. R., Poland, Germany, Baltic States, Belgium and Ulster (Northern Ireland).

U. S. S. R. ...	1200 millions	of Bushels	of fibre	
Poland ...	100	,,	,,	,,
Germany ...	100	,,	,,	,,
Lithuania ...	90	,,	,,	,,
Japan ...	85	,,	,,	,,
Latvia ...	85	,,	,,	,,
Belgium ...	85	,,	,,	,,

Linseed is grown in many sparsely populated regions like portions of Argentine, U. S. S. R., India and the spring Wheat Belt in U. S. A. In India it is grown as a winter rotation crop.

Argentine ...	70 million	pounds	of	seeds.
U. S. S. R. ...	26	,,	,,	,,
India ...	18	,,	,,	,,
U. S. A. ...	10	,,	,,	,,

In the case of cultivation of fibre, huge labour is needed and it will be seen that it is grown in very densely peopled temperate lands. Much linen is manufactured in British Isles, Ulster (Belfast), north-eastern France and Poland. In U. S. S. R. and in the Baltic States linen-making is carried on as a cottage industry.

A lot of Russian flax is exported to Ulster and other coal areas of North Western Europe.

Rubber

Rubber was unknown outside the tropics until about the 16th century and it was not even upto the 18th century that Europe paid any special attention to it. It was only in the year 1889 when an American inventor, Charles Goodyear discovered that chemically treated rubber could be made into a product that would wear well and not change with temperature. The whole rubber industry was revolutionized and a world-wide demand for rubber was created.

Rubber comes from the sap of various trees originally growing in the equatorial forests. The best rubber trees are found in the Amazon basin. Rubber trees grow only in very hot and very wet climates. An average temperature of 80° F and a yearly rainfall of 100 inches are the most favourable conditions for their growth. Soils should be fertile but not subject to flooding.

Climatic Conditions Suitable for Rubber

	J	F	M	A	M	J	J	A	S	O	N	D
Temp.	80	80	81	82	82	81	81	81	81	81	80	81
Rain-fall	9·9	6·6	7·4	7·6	6·7	6·8	6·8	7·9	6·9	8·1	9·9	10.6

Rubber that is gathered from trees in the equatorial region is known as wild rubber as the trees grow there wildly and as a natural course. Wild rubber has recently been supplemented by cultivated or plantation rubber of South-eastern Asia and East Indies where regular rubber plantations have been installed under foreign supervision and now nearly the whole rubber supply comes from these plantations and the importance of wild rubber has practically dwindled to zero. The following figures show this comparative study :—

Year	Percentage of plantation rubber	Percentage of wild rubber
1900	100	0
1910	90	10
1920	12	88
1930	2	98
1938	2	98

Rubber Plantations.—With the increasing demand for rubber in most of the civilized countries of the world and more particularly in Europe, people began to consider the possibility of growing rubber as a plantation crop in the newly-acquired tropical colonies rather than get it from the wild and unhealthy jungles of the Amazon basin, and Central Africa. Preliminary experiments proved encouraging and plantations were started in Ceylon as early as 1873. In the next thirty years or so quite a large area in the East Indies was occupied by rubber plantations, so much so that as early as 1910, these areas exported about 12 thousand tons of rubber and ever since then plantation rubber has been gaining in importance and wild rubber losing its old significance because " the wild industry needs high prices to cover its high costs and because it cannot compete with plantation production."

Now plantations exist in British Malaya, Sumatra, Java, Ceylon, British Borneo, French Indo-China, Thailand(Siam) and South India. It may, however, be noticed that plantation rubber thrives in the same latitudes as wild rubber because the environmental requirements of rubber can only be had in these latitudes.

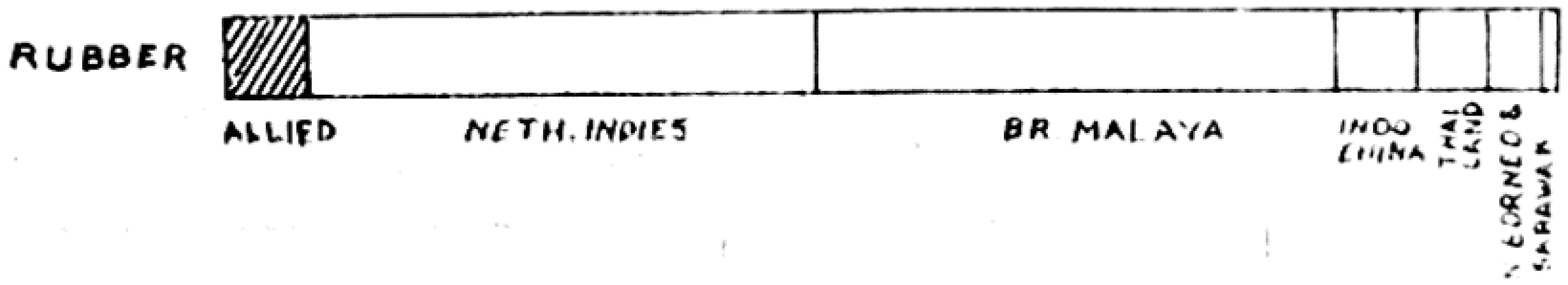

Fig. 9.

The total rubber production of the world is about 1,081,000 metric tons out of which about 869,000 metric tons is plantation rubber while the rest (162,000 metric tons) comes from wild sources. The following table shows figures for various countries :—

British Malaya	...	475,000	Metric tons	per year.
Dutch East Indies	...	384,000	,,	,,
Ceylon	...	80	,,	,,
British Borneo	...	24	,,	,,
South India	...	12	,,	,,

East Indies and Indo-China alone claim about 90 p. c. of the total world praduction. Ceylon alone supplies about 60 p. c. of the British Empire total.

The average yield per acre of rubber in these plantations is about 1,500 pounds as compared to 400 lbs. per acre of the Amazon Basin.

The reasons for this rapid and successful development of plantation rubber may be summarized as given below :—

(1) Suitable physical environment (in climate and soil).

(2) Cheap and abundant native labour is easily available. Many workers have also migrated from the neighbouring areas to the plantations.

(3) The production is much orderly and systematised under efficient supervision.

(4) As the production is carried on on relatively small islands or on the coastal regions, transportation is easy.

(5) Firm and stable administrative and financial control.

(6) Improved and labour and time saving instruments are used.

Trade.—Most of the producers are also the main exporters. The following table shows the export figures :—

Country	Actual exports	Percentage of the total
	million lbs.	
British Malaya	1300	53%
Netherland Indies	650	30%
Ceylon ..	150	5%
Indo-China ...	100	3%
Brazil ..	50	2%
British Borneo	50	2%
British India	50	2%

Export figures in rubber for the world are fairly synonymous with production figures as nearly all of the rubber produced is exported to the temperate industrial countries and not much is used in the tropical regions.

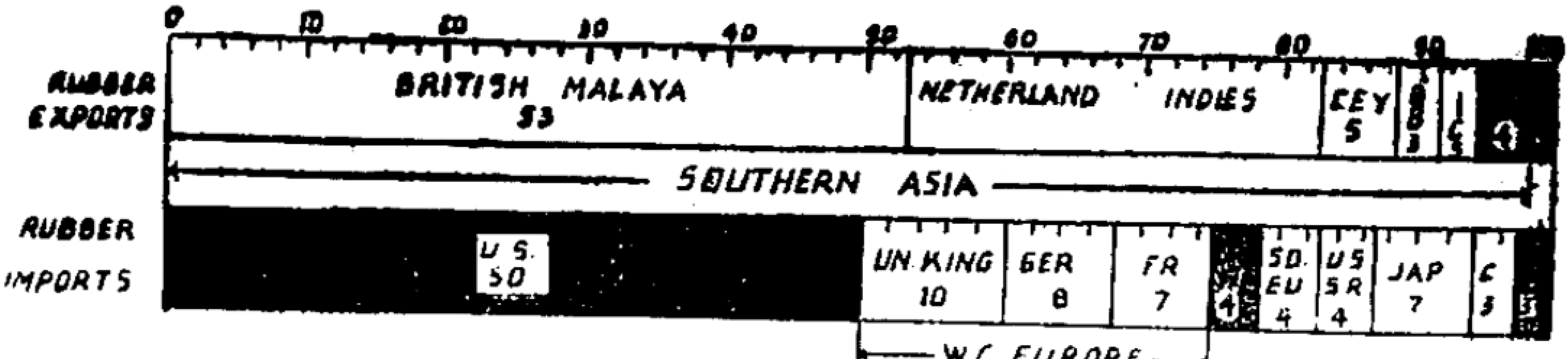

Fig. 10.

There has been a tendency to over-produce and this resulted in a drastic fall in prices. The Stevenson scheme affecting only the British plantations, urged limited rubber production and export, the actual figures fluctuating according to the demand, etc. But this did not affect other plantations and things did not improve. In order to ameliorate matters, a new international scheme of limited production and export came into force in 1934.

U. S. A. and United Kingdom are the chief importers of rubber as they need a lot of rubber for their automobile industry. London has since long been the central market and warehouse for rubber but now U. S. A. gets all her supplies directly from the producers. The diagram shows the percentages of imports and exports.

Gutta-Percha, *Balata and Chicle* are also rubber-like substances gathered from some wild tropical trees. Balata is had from the forests of north-eastern South America and chicle which is used for making chewing gum, is obtained from Central America.

Oilseeds

Oilseeds are in great demand for extracting vegetable oil which is used both as a dressing for salads and other articles of food and also for the manufacture of toilet articles and lubricants, etc. The chief sources of oil are cotton-seeds, copra, olives, palm-nuts, ground-nuts or peanuts, sesame, linseed, castor-seed and soya beans all of which usually thrive in tropical and sub-tropical climates.

Cotton-seed is largely produced in U.S.A., India and Egypt. U.S.A., exports very little of her produce because there is not much surplus after meeting huge internal consumption.

Olives are used for extracting oil and also for making pickles. Olive oil can be used in a number of ways both as an article of food and for making perfumery, jams, etc. Olives thrive in Mediterranean lands. Spain is the largest producer of olives. Italy, is next in importance. Both the countries claim about 80 p.c. of the total world production of olives.

Copra is used for extracting coco-nut oil. Coco-nut palm is an important plant of the Pacific Islands. Malaya also produces huge quantities.

Rape seed oil is derived from a species of mustard. It is a crop of temperate regions.

Linseed or flax seed is also an important item under this heading. Details about its production, etc., have been given under Flax.

Pea-nuts are important in U.S.A.. India, Africa and China. They are usually grown as a rotation crop.

The Twig tree has now been introduced in U.S.A. and many other regions. The nuts are used for extracting oil which is used chiefly for making paints, varnishes, etc.

Soya Beans are largely produced in Manchukuo, Japan and China. India and U.S.A. also produce some Soya Beans.

CHAPTER IV

ANIMAL AND PASTORAL PRODUCTS

Certain animals like the sheep, goats, cattle, horse and pigs supply us with both food and raw materials for clothing, etc. Animal Products, therefore, may be classified as (1) Raw materials and (2) Food. The latter include meat, milk, butter, cheese, etc., while wool, hides and skins form the chief components of the former.

SECTION A

Wool, Hides and Skins, etc.

(1) *Wool* is obtained chiefly from sheep. Its quality as well as quantity differs according to the breed of the animals concerned. The climate plays a very useful role in determining the breed of the animals. Camel and goat wool is also important in certain areas like Persia, Arabia, North Africa and Central Asia. But this wool plays only a minor role in the world wool distribution. Quality and Quantity of wool has also been improved in certain places by the modern methods of cross-breeding. Constant care and restocking is necessary to maintain high quality. Long-fibred wools are the most valuable and are used for making costly and fine articles of clothing, while short-fibred wools are supposed to be of a low and coarser quality and are used for the preparation of carpets, blankets and rough cloth.

Two kinds of sheep are usually differentiated, *viz.*, (1) Wool sheep and (2) Mutton sheep. Wool sheep have a very fine growth of fine, silky wool. These are no good for mutton ; while the mutton sheep produce high grade meat and live in more humid climates. Their wool is short-fibred and coarse.

Best sheep are usually found in warm temperate regions because this climate is good for wool growth. Comparatively drier regions are better suited for wool sheep. The best sheep-raising (and consequently wool-producing areas) are situated in thinly populated grasslands of the temperate zone. The following table shows the country-wise distribution of sheep. The geographical distribution of wool is very much similar to this :—

Australia	...	114,000,000 sheep.
U.S.A.	...	49,766,000 ,,
South Africa	...	48,700,000 ,,
U.S.S.R.	...	45,700,000 ,,
Argentine	...	44,440,000 ,,
India	...	43,581,000 ,,
New Zealand	...	27,756,000 ,,
China	...	26,000,000 ,,
U. K.	...	25,800,000 ,,
World Total	...	792,200,000 ,,

More than 3/5 of the total sheep are found in the temperate areas of the Southern hemisphere. Australia is by far the greatest sheep-raising country and there the chief sheep regions lie to the east of the great Dividing Range, stretching from the very south (Murray Basin) to central Queensland. The province of New South Wales produces more than half the total Australian wool.

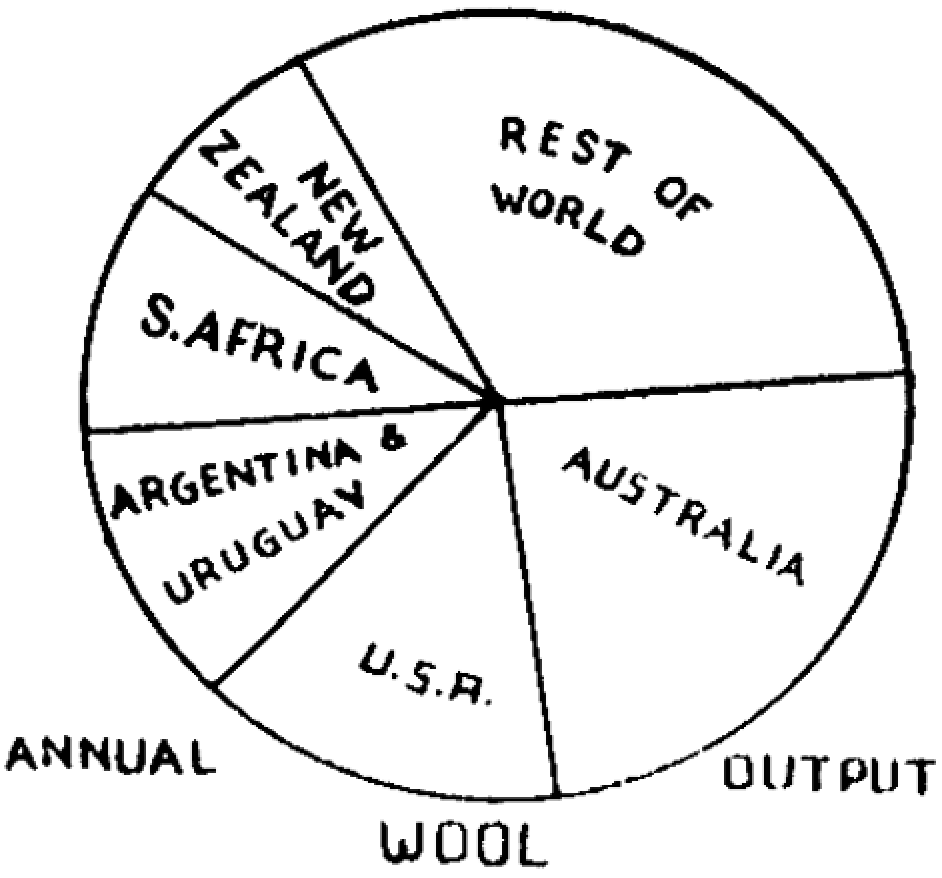

Fig. 11.

The following table shows the world distribution of wool :

Australia	...	1000	millions of pounds.
U.S.A.	...	425	,,
Argentine	...	375	,,
New Zealand	...	300	,,
Union of South Africa		225	,,
Uruguay	...	110	,,
U. K.	...	100	,,

The finest grades of wool come from Merinos and certain Merino cross-breeds. The Merino is the native of the Atlas region and is also associated with the Meseta of Spain. To-day Merino has been introduced to nearly all the important wool-producing regions. In certain areas specially in the wetter regions of New Zealand, Victoria and the lower valley of the river Plate, both the wool-sheep and the mutton-sheep have been crossed and both wool and mutton are had from the same sheep.

The trade in wool is very simple to understand. The temperate grasslands of the Southern Hemisphere supply about 415 of the world's export of wool :—

Australia	37	p.c. of total world exports.
Argentine	13	,,
New Zealand	12	,,
Union of South Africa	11	,,
Others	4	
Total	77	

Most of the imports are claimed by the manufacturing countries of Europe :

United Kingdom	26	p.c. of total imports.
France	16	,,
Germany	15	,,
Belgium	9	,,
Southern Europe	6	,,
Others	5	,,
U.S.S.R.	4	,,
Total	81	

Other importers are United States (8 per cent) and Japan (9 per cent).

Hides, Skins, etc.

Hides and skins are also important items of raw material supplied by these animals. Leather is made out of these. There are no special breeds of cattle, sheep and goats, etc., that supply leather, all breeds are equally important. Leather is of great importance to us and its demand is ever on the increase, so much that hides and skins form a regular part of international trade. U. S. A. imports half of her leather requirements. Sheepskins and goatskins are also important. Germany and U.S.A. are important for their tanning industries.

Bones, horns, fat and hoofs are useful by-products of the animal industry. They are put to various uses. They also come from the great cattle fields of the world.

SECTION II

(FOOD PRODUCTS)

1. **Meat** may be described under three headings. Mutton, Beef and Pork.

(*a*) *Mutton.*—The distribution of sheep has already been described under wool. As sheep are the chief source of mutton, it is also had from more or less the same regions, the only difference being that areas that specialize in wool do not so much specialize in mutton as most sheep reared by the people there are meant only for wool and *vice versa.* New Zealand, Australia, Argentine, Uruguay and Netherlands are the chief mutton producers as well as exporters of mutton. The following table gives the export figures.

New Zealand	400	Millions of Pounds
Australia	200	,,
Argentine	120	,,
Uruguay	25	,,
Netherlands	10	,,

Many of the sheep in British Isles are reared for both mutton and wool. Sheep for mutton usually thrive on good pastures with sufficient rains. In New Zealand, the Canterbury Plains are the chief sheep lands. In Uruguay the Plate Plains have a number of sheep.

Britain, inspite of the its sufficient mutton production is the chief importer of mutton claiming about 95 per cent of the total world imports.

(*b*) *Beef.*—Cattle thrive on rich pastures having good rainfall. India has perhaps more cattle than any other area in the world but on account of religious reasons, the beef industry is not at all important. The plains of Western Europe, the Maize Belt in North-Central plains and the high Western Plains of U.S.A. and the temperate low lands of South America are by far the most important cattle-rearing regions. Other important areas include South Eastern coast of Australia, Central Europe, South Eastern Africa and South Brazil.

The total exports of beef and products are estimated at 2,037 Millions of pounds (1937 figures), out of which nearly half is claimed by Argentine. The following table shows the export figures for beef and beef products.

Total	2,037	Millions of Pounds
Argentine	1,139	,,
Australia	308	,,
Uruguay	225	,,
New Zealand	170	,,
Denmark	54	,,
U.S.A.	41	,,
Netherlands	37	,,

United States claim about 75 per cent of the total beef imports. Other beef importers are Southern European Countries (4 per cent), France (3 per cent), Germany (2 per cent) and Belgium (2 per cent).

(c) *Pork and Bacon.*—The geographical distribution of swine and pigs depends more on economic reasons than on climatic conditions. In many Muslim areas, the number of pigs is very small because of religious hinderances. The United States of America, Western Europe and extreme Eastern Asia (China) are very important regions. Eastern South America is also of considerable importance.

Swine (or better Hogs) are meant for bacon and also for lard. The lard type is mostly raised in U.S.A. Corn Belt. There they are fattened on corn. In Western Europe, the bacon type predominates. The pigs of Eastern Asia are of a low quality and they are neither important for bacon, nor for lard. On account of huge population, there is not much food left for animals there and pigs usually feed on domestic garbage. But all the same, Eastern Asia specially China has more pigs than any other country.

U.S.A., Denmark, Netherlands and Canada are by far the most important pork and bacon (including other allied products) exporting countries in the world and claim about $\frac{3}{4}$ of the total exports. United Kingdom, Germany, Cuba, Belgium and France are the chief importers.

2. *Milk, Butter and* Cheese *etc.*—The most important Dairying regions are the St. Lawrence Basin and portions of Eastern U.S.A., west Central Europe, Argentine and New Zealand. New Zealand, and Canada (Chiefly Quebec) are important Cheese suppliers. Denmark, France, and Holland, New Zealand and Argentine give us most of our butter. Fresh milk is an article of local trade, but condensed milk is largely exported from Holland,

Belgium, France and Norway. The following table shows butter export figures :—

		Millions of Pounds	(1937 figures)
Denmark	337	,,	,,
New Zealand	333	,,	,,
Australia	188	,,	,,
Netherlands	119	,,	,,
Eire (Ireland)	43	,,	
Argentine	19	,,	,,

Poultry

Poultry includes the common foul, duck, goose, and the Turkey. They are domesticated for meat, eggs and feathers. Poultry is the most universal of all animal industries. U.S.A., Denmark, Holland are, however, the chief poultry producing countries.

Denmark is an important exporter of eggs ; other suppliers being Holland. Poland, Belgium, China and Canada. Several European countries export poultry. China Turkey and the Balkans export a lot of egg powder and frozen eggs.

CHAPTER V

FOREST PRODUCTS

The vegetation map of the world given in the chapter on 'Biogeography' in Part I of this book, shows extensive forest areas in the following regions :—

1. Intermediate Climates

(a) North-Western United States.
(b) South-Western Canada.
(c) North-Western Europe.
(d) Southern Chile.

2. Humid Continental Climate

(e) Central and Eastern Europe.
(f) Northern China.
(g) North-Eastern U.S.A.

Nearly a quarter of the total area of the world is covered by forests. The three main types of forests are (1) The temperate coniferous softwood forests, (2) The temperate hardwood deciduous forests, and (3) The tropical hardwood forests. The following table gives some useful figures about the world distribution of forests.

Continents[1]	Total Forest acreage.[2]	Acreage of Conifers.	Acreage of Temperate Hardwoods.	Acreage of Tropical Hardwoods.
Asia ...	2096	889	572	635
South America ...	2093	109	115	1869
N. America ...	1444	1046	290	108
Africa ...	797	7	17	773
Europe ...	774	579	195	0
Australia ...	283	15	15	253

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[1] This table has been adopted from 'Forest Resources of the world' as quoted by Jones and Darkenwald in 'Economic Geography' published by the Macmillan Company, New York (1941).

[2] In Millions of acres.

The coniferous forests consist of firs, larches, pine, cypresses and many others. The coniferous forest belt supplies about 50 per cent of the total wood of the world. Pine because of its softness is the chief timber of commerce.

Oak, maple, ash, birch and walnut form the chief varieties found in the temperate hard wood or deciduous forests. Deciduous forests supply about 35 to 40 per cent. of the total timber. The wood from this region is mostly used for furniture-making.

In the Tropical hard woods teak, ebony, rose wood and mahogny are the chief types found. Owing to certain inherent difficulties, however, they are but little exploited.

About 80 per cent of the wood that enters trade is ' soft wood ' obtained mainly from firs and pines. It is greatly used for making wood pulp for paper. Oak is very largely exported from both the American as well as from the European countries. Teak is of great value for general construction and shipbuilding. It is chiefly exported from Burma and Siam (Thailand), Ebony is a native of India. Jarra and Karri are now chiefly exported from Western Australia and are in great use for railway sleepers, paving blocks, etc.

Furs.—For the supply of fur, one has to depend upon the northern hunter, including the seal-fisher. Fur trade deals in the skins of a number of animals found chiefly in the cool forests of the northern hemisphere. The furs obtained from North America and the adjacent seas are collected to a large extent in New York. London is also an important fur market. Leipzig in Germany is also a very important fur collecting station. Most of the Russian fur is collected at Gorky.

The fur trade of North America was for some time a monopoly of the Hudson's Bay Company. Now, however, there are several other fur-dealing companies.

The latest innovation in the fur trade has been the breeding of certain fur-bearing animals chiefiy the silver-fox, in Canadian farms.

Ivory comes chiefly from Africa where 15,000 to 20,000 elephants are killed annually. London is the chief ivory market from where much is purchased by the eastern countries to be made into small carvings. *Vegetable Ivory* is a kind of seed native to South America and is used for the preparation of buttons etc.

Paper.—Over 90 per cent. of paper is made from wood-pulp prepared from the timber of cool forests. The woody fibre of pines and spruce is ground down to a pulp and exported as pressed boards or sheets. Some grasses are also used for making paper. Special mention may be made of the Alfa grass of North Africa, Esparto grass of Spain and the Delta grass from the plains of Rumania. In China and Japan where the Mulbery tree is abundantly grown the inner bark of that tree is used for making strong paper.

The world production of paper is estimated at 1,000,000 tons. The chief paper-producing countries being U.S.A., Canada, Germany, Finland, U.S.S.R., and Sweden.

Cork is the bark of an Oak tree found chiefly in the Mediterranean regions. Raw cork and also cork products are the chief exports of Spain, Portugal, Morocco and Algeria.

Besides supplying the above, forests also have some indirect uses to man. These may be summarized as under :—

(*a*) The presence of forests has a tempering effect on climate, and rainfall tends to increase.

(*b*) They protect the earth's surface from rapid soil erosion and also increase the fertility of the soil.

(*c*) Forest obstructions tend to taper down the velocity of winds.

CHAPTER VI

(FISHERIES)

Fishing has now come to be an important source of human food and its importance is ever on the increase.

Fish live where sun-light is able to penetrate the ocean bottom and this enables plant-growth. Hence fishing is most important in shallow sea-regions specially on the shallow banks (*e.g.*, the Great Banks of New Foundland) and on the continental shelves. But the fish resources of the world have not yet been fully exploited.

The great commercial fisheries of the world lie in the cold, shallow coastal waters or rivers or on the banks of submerged plateaus in northern latitudes, where fish gather to feed or where deep-sea species of fish come to spawn. In these areas, Cod, Mackerel, Herring, Flounder and Halibut are the chief species found. Tropical fish are usually bad in taste and quality. The most important fisheries are (1) the banks of the North American coast from Labradar to Cape Cod specially along the banks of New Foundland and New England, (2) the North sea fisheries extending from Spain to the Arctic, Dogger Bank region being the most important, (8) and the banks of Iceland and Norway. The great fishing countries. *i.e.* Britain, Scandinavia, New Foundland and Nova Scotia export a lot of Cod and Herring (and also Cod and Halibut Oil) chiefly to Latin America and Central and Southern Europe.

The Mediterranean sea warm-water fisheries are important for Sardines, Tuna and Mackrel. Similar catch is important along the banks of Southern California.

Japan has made a tremendous development in fishing industry along its coast during recent years. But most of the catch there is consumed locally ; there fish has largely replaced meat in the Occidental diet. Some canned fish is, however, exported.

River fisheries have gradually dwindled in importance. Salmon is the most important river fish. To-day the

Salmon industry is important only in the Pacific area of North America. Salmon-canning is consequently an important industry in that area and canned salmon is the most important export. The Russian rivers abound in Sturgeon.

In the Southern Hemisphere, most of the fisheries are neglected.

The world catch is estimated at about 12,500,000 tons. The following table gives figures for important fishing countries :

Japan	...	4,000,000 tons.
U. K.	...	1,100,000 ,,
Korea	...	1,500,000 ,,
U.S.A.	...	1,300,000 ,,
U.S.S.R.	...	1,400,000 ,,
Norway	...	1,100,000 ,,
Canada	...	510,000 ,,
Germany	...	500,000 ,,
Spain	...	390,000 ,,
France	...	330,000 ,,
Iceland	...	240,000 ,,
Holland	...	240,000 ,,
Portugal	...	210,000 ,,
New Foundland	...	80,000 ,,

Whale and Seal are non-edible species. Whale oil was the chief illuminating oil before the use of petroleum as such, and therefore, whaling was a very active and important industry. Now the products of the whaling industry are mostly used for leather dressing and for the manufacture of soaps. Whale is usually found in the Arctic waters between New Foundland and Norway.

Seal is caught for its skins which are tanned and used for a variety of leather goods. Seal oil is useful for soap-making. They are also found in the Arctic waters. New Foundland, Norway and Russia are the leading exporters. Pearls come from the coasts of Ceylon, the Persian Gulf and parts of the East Indies. Mother-of-Pearl and trochas—shells are the product of the Pacific Islands and of the Northern coasts of Australia.

In Japan Oysters are often artificially irritated so that they will manufacture pearls but these manufactured pearls are far inferior in quality to natural pearls. Oysters are also artificially propagated in many other areas on extensive Oyster farms.

CHAPTER VII

(SOURCES OF MECHANICAL POWER)

Power is of utmost importance in the economic development of a state. Upon it depend all processes of manufacturing and transport. A lack of power may mean the breakdown of a nation's economic and industrial structure.

In the early days of Man, human energy was the only available source of power. After some time man secured the assistance of animal power and then he harnessed wind power by means of crude wind mills. Then water power was utilized for working looms, etc. With rapid industrial and scientific development, better, cheaper, and more abundant means of mechanical power came to be used for commercial production of things. Coal, petroleum and water are to-day the main sources of mechanical power. It is, however, hoped to use the energy of the tides and the sun for our industrial purposes in a course of few years when the experimentation stage is completed.

COAL

Coal mining is one of the most important industries of to-day and coal is the most extensively used source of power for mining, manufacturing and transport industries, so much so that it effects the location of an industry much more than any other factor. The coal regions of Germany, Great Britain and U. S. A. are also the greatest manufacturing regions in those countries.

The use of coal is of quite a recent introduction. It was only in the early eighteenth century that coal was used for smelting iron ore. This useful introduction brought about an industrial revolution. More and more machinery driven by mechanical power derived chiefly from coal, came to be used and industries began to be localised on coalfields as it is rather uncommercial to transport coal on a large scale.

Coal occurs in the following three varieties :—

(*a*) *Anthracite* contains about 80 per cent of carbon and has a peculiar lustre on the surface. It is a clean variety and does not soil the fingers. It is capable of producing great heat and is very useful for smelting and other industries where very high temperatures (about 3000OF) are required.

(*b*) ***Bituminous*** has a lower percentage of carbon but a higher percentage of tar and gas. It burns with a bright flame and is rather smoky. It is greatly used for the production of coke and gas.

(*c*) ***Lingite*** is a poor variety of coal with very low percentage of carbon. It is also known as Brown Coal and burns with a peculiar smell.

The world is endowed with a huge amount of coal. Sufficient quantities lie within easy reach of Man—about 6,000 feet and above. The annual coal production of the world is estimated at about 1300 Million Metric tons. The following table gives individual figures also see fig. No. 15.

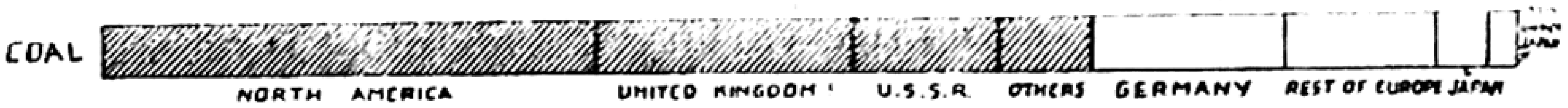

Fig. 12.

U. S. A.	410	Millions	of Metric	Tons.
U. K.	230	,,	,,	,,
Germany	180	,,	,,	,,
U. S. S. R.	125	,,	,,	,,
France	45	,,	,,	,,
Japan	40	,,	,,	,,
Poland	40	,,	,,	,,
Belgium	34	,,	,,	,,
China	30	,,	,,	,,
British India	25	,,	,,	,,

It is surprising to learn that coal production has tremendously increased during the last half century. In many cases, the increase is more than 20 times. The following table gives coal figures for 1881—85 (yearly averages) :

U. K.	158	Millions	of Metric	Tons
Germany	58	,,	,,	,,
U. S. A.	95	,,	,,	,,
France	19·4	,,	,,	,,
Belgium	17·3	,,	,,	,,
U. S. R.	3·8	,,	,,	,,
India	1·2	,,	,,	,,

United States of America are the greatest coal producers and claim about 43 per cent of the world total. Nearly half of U. S. A. coal comes from the Pensylvanian coal fields; other important coal mining areas are :

(1) The Applachian Coalfields.
(2) Kansas.
(3) Indiana.
(4) Missouri, and
(5) Dakota.

In British Isles nearly 95 per cent of the total produce is had from the main land (Great Britain), where the Scottish Coalfields (Clyde Valley and along the Firth of Forth), the Penine region (Lancashire and Yorkshire), the Midland Region and South Wales supply the bulk of total coal. Britain has an important export trade in coal.

Germany is of equal importance in coal. She has the largest percentage of Lignite variety. The most important coalfields are situated in Saxony, Silesia, Saar, Ruhr Valley and Bavaria. Saar and Westphalia Coalfields in Western Germany supply about four-fifths of the German total.

The Sambre—Mensa Coalfield supplies the major portion of coal in France and Belgium. Holland also gets its coal from the Northern most part of this field and from portions of Aachen Coalfield that lies partly in Germany.

U. S. S. R. has huge coal reserves. Donetz basin is the most important coal-producing area in U. S. S. R. Ural and Toula are also important coal-mining centres.

Asia does not produce much coal. Some coalfields of importance lie in China, Japan and British India. Kuznetsk region in Asiatic Russia is also important. It is, however, reported that Asia has huge coal reserves specially in Asiatic Russia and China.

The entire southern hemisphere produces only about 2 per cent of the world total of coal. South—eastern Australia, Union of South Africa and Middle Chile have the chief fields.

More than half of the total coal produced is used for manufacturing purposes. Railways and Ocean transport also claim quite a good per centage. Some coal is used for domestic purposes while considerable quantities are exported. The following table gives a rough idea about how most coal is used in U. K., U. S. A. and India.

Uses	U. K.	U. S. A.	India.
Manufacturing industries etc.	45 per cent.	57 per cent.	40 p. c.
Domestic	16 ,,	13 ,,	20 ,,
Export	19 ,,	2½ ,,	0 ,,
Transport (Railways, ships etc.)	6 ,,	21 ,,	—

Trade:—There is only a small trade in coal because perhaps of its heaviness. Most of the coal trade is done by water. Most of the coal exports come from Britain because perhaps most of her coalfields lie near the sea and hence it is easier to transport it. The chief importers are France, Italy, Holland, Belgium, Canada and South America.

By-Products:—The principal by-products of coal obtained chiefly by distillation are *coal gas* used mainly for lighting and heating, *ammonia*, *ammonium sulphate*, *coal tar*, *pitch* and *coke*; coal-tar further distilled yields benzol, naptha, light oil (used for making dyes), carbolic oils and creosote oils used for preserving timber.

The possibility of an early exhaustion of coal resources has very often been under discussion. It is estimated that easily mined coal resources are about 7,397,553 million metric tons and this reserve might last for 6000 years. In 1905 it was reported that Great Britain had coal sufficient to last for 300 Years. Recent investigations have, however, extended the area of possible coalfields in Great Britain. Economy in the expenditure of coal is a foregone conclusion, if at all we have to have security against a paucity of coal in the future.

The coal reserves of the world are estimated in the following percentages :—

U. S. A.	51 per cent.
Canada	17 ,,
China	17 ,,
Europe	10 ,,
Oceania	3 ,,
Siberia	2 ,,

PETROLEUM

Due to its easy and cheap transportability petroleum has tremendously gained in importance during recent times. The industry began to grow in 1900. Its remarkable growth may be judged from the following figures.

Year	World Output in Millions of Barrels (42 Gallons).
1908	195 ,, ,, ,, ,,
1918	1019 ,, ,, ,, ,,
1926	1816 ,, ,, ,, ,,
1930	1500 ,, ,, ,, ,,
Average of 1936—38.	1,978. ,, ,, ,,

The most important producer is U. S. A. Being highly motorised, it is also the biggest consumer. Mexico also produces some oil.

It is impossible to describe the exact location of petroleum fields. New fields are being found roughly at the rate of one every month and old ones are being exhausted. Only general remarks about the occurrence of oil can, therefore, be made.

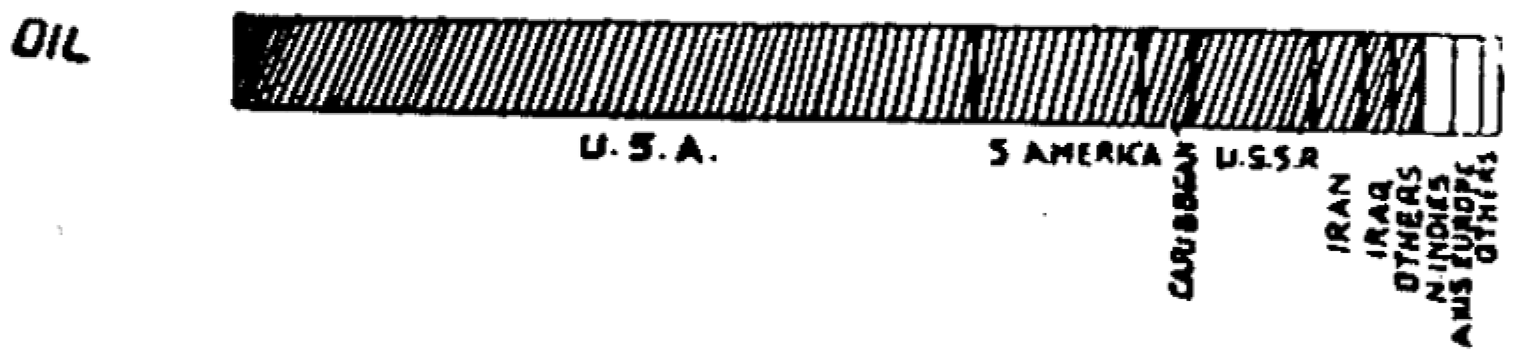

Fig. 18.

After U. S. A. Russia is the most important producer. Already the average annual output is about 169,000,000 barrels, and the potentialities of expansion are also great. The Ural is an important source, if properly explored.

In Europe the outer slopes of the Carpathians, Poland and Rumania are the main oil producing areas.

A few wells have been found in Germany. French output is insignificant.

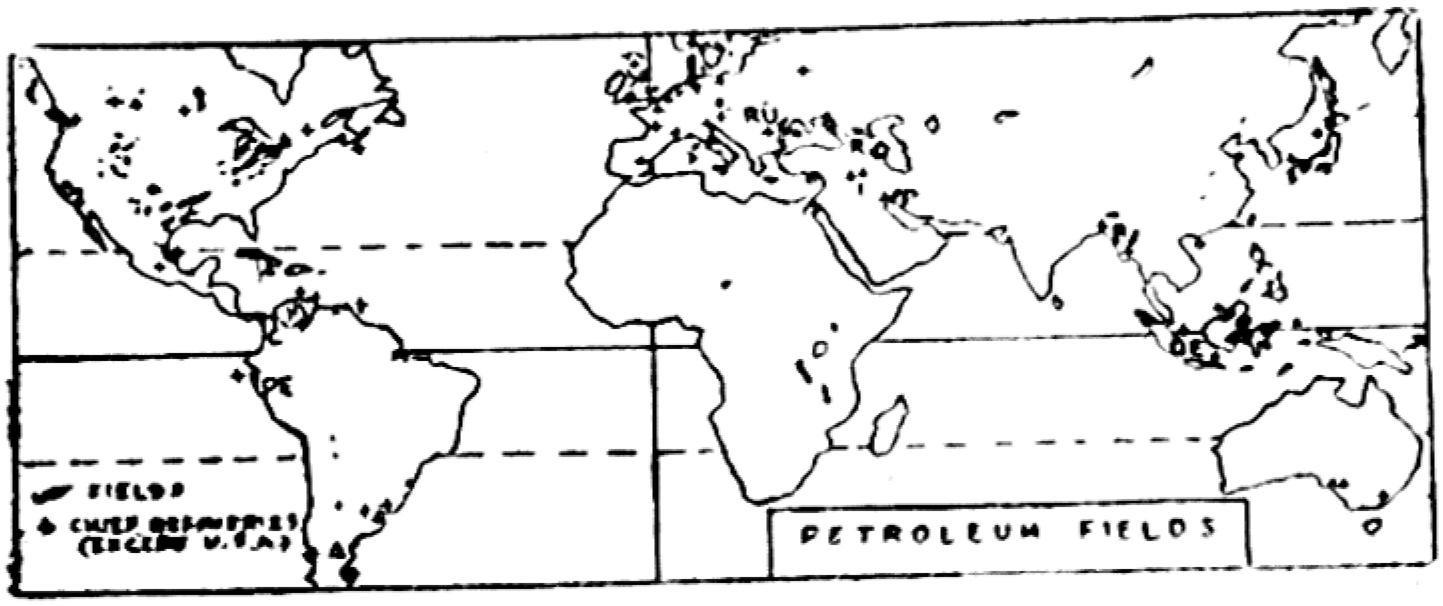

Fig. 14

S. America :—The industry has made rapid progress. Venzuala ranks third amongst the producers of oil in the world with its 202 million barrels per year. The small British controlled island of Trinidad is also important. Excepting the state-owned Oil-fields in Argentine, most of the fields are under British and American interests.

Asia :—Persia, Iraq and Burma are the main producers.

Burma's peace-time production is one million Barrels.

Persia produces 48,470,000 barrels (mainly in Maidan-i-Suleiman worked by the Anglo-Iranian Oil Company). A pipe line runs from the fields to the head of the Persian Gulf.

In Iraq *Mosul* Oil-fields, are the most important. They have been connected by means of a pipe line to Haifa.

There are small fields in Attock District in the Punjab, and near Digboi in Assam. Java, Sumatra and Borneo also produce oil. An oilfield has been recently found in N. E. Arabia.

Australia and South Africa :—Various experiments and explorations which have been carried on, have failed to locate any important fields.

The following table gives approximate production figures for main producers (1938).

Country.	Production in Millions of Barrels.	Percentage of World total.
U. S. A. ...	1,213	61·3
U. S. S. R. ..	202	10·2
Venezuela ...	187	9·5
Iran (Persia) ..	77	3·9
Netherlands (India)	57	2·9
Rumania ...	48	2·4
Mexico ...	35	1·8
Iraq ...	33	1·7

Uses of oil :—The oil or its products are widely used as illuminants, lubricants and fuel. Petrol or gasoline used in automobiles is a 'violatile distillate' of petroleum. Kerosene or Paraffin Oil is a 'light distillate' used for illuminating purposes. Naptha, Benzine and Vaseline are other products of petroleum. Mineral oils are displacing vegetable oils for many purposes.

As a fuel the greatest advantages of petroleum are.

(1) Its greater calorifice power.

(2) Its more complete combustion,

(3) Its greater convenience in storing and transport by means of pipe lines.

(4) Its cleaner outlook.

Other fuels :—(*a*) The latest innovation is to produce petrol from coal.

(*b*) *Alcohol* is used as a substitute for petrol as a fuel. It is cheaper and its sources of supply are inexhaustible. It is produced from a number of vegetable materials.

(*c*) *Natural gas* is a light petroleum product. It is conveyed to the areas of consumption by pipe lines. It is of considerable importance as a cheap fuel.

In modern warfare, oil plays the leading role. It may not be very wrong to remark that "Oil will win the war."

The known reserves of oil are not very huge. Some experts are of the opinion that a few decades may see the complete exhaustion of our oil resources. Many oil-fields have finished yielding and there is always a search for new fields.

WATER POWER

Water supplies the cheapest type of motive power. In the past the force and weight of water was used for turning old mill wheels. Science has now developed a new phase in the utility of water power—the production of electricity. Electricity thus produced can be easily transmitted to fairly long distances by means of cables with only an insignificent loss of energy during transit. This has considerably made industry independent, as far as its location is concerned. The industrial dependence on coal and also the coal-control of the location of industries are both losing weight. The only defect, if it could be called a defect at all, is that large initial expenses have to be incurred in constructing headworks for generating power.

The development of water-power, however, depends on the supply of water and the relief of land. The required volume of water must flow regularly at all seasons and must descend rapidly to provide a 'head'. Geographically speaking, therefore, water power can best be developed (1) in rugged relief or highly glaciated areas, (2) where the volume of water is constantly uniform—both low waters and floods are injurious, and (3) where the sight of power or the 'head' is easily accessible.

Besides the above points, it is desirable that the place of consumption be not very far away from the source. The following table shows that after 400 miles or so, the application of water-power hardly remains commercial.

Table showing rate of loss of energy during transit.

100 miles	8 p. c.
200 miles	10 ,,
300 miles	13 ,,
400 miles	17 ,,
500 miles	21 ,,

Water power proves more useful and commercial where coal or petroleum is not cheaply available, and where water can be used for irrigation thus yielding an extra income.

Water power or '*White Coal*' is a thing of very recent creation. It was only in the year 1869 that the first hydraulic power plant was erected in the French Alps. The development that has come into evidence during the last seventy five years or so is really phenominal. But much more is still to be done in this direction. Only about 8 per cent of the total potentialities have been exploited and this figure is certainly not at all praise-worthy. It only shows that water power has been developed only in very few places while the bulk of the potentialities still lie untouched. The following table presents a comparative study of the entire problem.

Continent	Potential reserves (Ordinary flow)		Developed	
World	671,000,000	Horse Power	60,000,000	H.P.
Africa	274,000,000	,,	175,000	,,
Asia	148,000,000	,,	5,400,000	,,
North America	77,000,000	,,	26,000,000	,,
South America	74,000,000	,,	1,100,000	,,
Europe	74,000,000	,,	27,200,000	,,

Thus Africa, Asia and South America have developed very little of their potential power, while North America and Europe have developed more than a quarter of their resources. The chief developed areas lie in the rugged, glaciated regions of the two northern continents(*i.e.* N.America and Europe). The greatest obstacles in the way of water-power development in Africa, Asia and South America are that most of the suitable sources of water power lie in difficult areas and in areas which are least developed economically.

Competition with coal is a very serious factor in the development of water power. British Isles have developed only 200,000 horse power while the potential reserves are much higher. The chief reason is the presence of coal mines. On the other hand in Italy, French Alps and Brazil, a high percentage has been developed because perhaps of lack of coal.

U.S.A. with Canada is the greatest producer of water-power (Hydro-electricity). There the chief developod areas are (*a*) New England States, (*b*) The Applachian region and the Southern Atlantic States and (*c*) The Niagra Falls. In the Pacific coastal area, some power has been developed as coal is expensive there. The Niagra Falls are shared both by U.S.A. and Canada.

In Europe greatest development has taken place in the Scandinavian Highlands, French Alps, The Alpine and the Appennine regions of Italy, Switzerland and Southern Russia, Japan has also developed much of her water power resources. India uses only a small portion of her reserves.

Many of the above-mentioned areas have no coal and depend solely on water power for use in their factories. U.S.A. has the greatest output of Hydro-Electricity but calculating on the basis of *Per Capita* consumption, Norway, Switzerland and Canada are the most 'lavish users'.

The table shows the potential reserves and the developed water power in important countries :

Country	Potential (Ordinary flow)		Developed	
U.S.A.	83,500,000	H.P.	17,119,610	H. P.
Brazil	36,000,000	,,	700,000	,,
Canada	25,500,000	,,	7,945,890	,,
France	6,000,000	,,	5,250,000	,,
Germany	2,000,000	,,	2,550,000	,,
Italy	5,400,000	,,	6,000,000	,,
Norway	16,000,000	,,	2,900,000	,,
Switzerland	3,600,000	,,	2,800,000	,,
U.S.S.R. (In Europe)	14,000,000	,,	1,463,000	,,
U.K.	700,000	,,	400,000	,,
India	39,000,000	,,	500,000	,,
Japan	7,200,000	,,	4,240,000	,,

Note.—The above potential estimates are based on ordinary minimum flow. In many cases the developed power has exceeded the potential because part of the developed power is available only during periods of high flow.

CHAPTER VIII

MINERAL RESOURCES

(A) Industrial Metals

Iron

Iron is the basic metal of the modern industry. It is used for making machines which are employed in manufacturing as well as in alround general equipment. It is extracted from the ores by smelting, a process in which coal and limestone are greatly in need. Various ores have widely different values. There are four important types of iron ores, Red ore or Hemtite, Brown ore or Limonite, Black ore or Magnetite, and iron carbonate or Siderite. 1, 2, and 4 are residual or sedimentary ores, while 3 is a primary ore which was formed with igneous rocks. Black iron possesses high iron content and has great magnetic qualities. Hemtite (Red ore) is one of the finest ores.

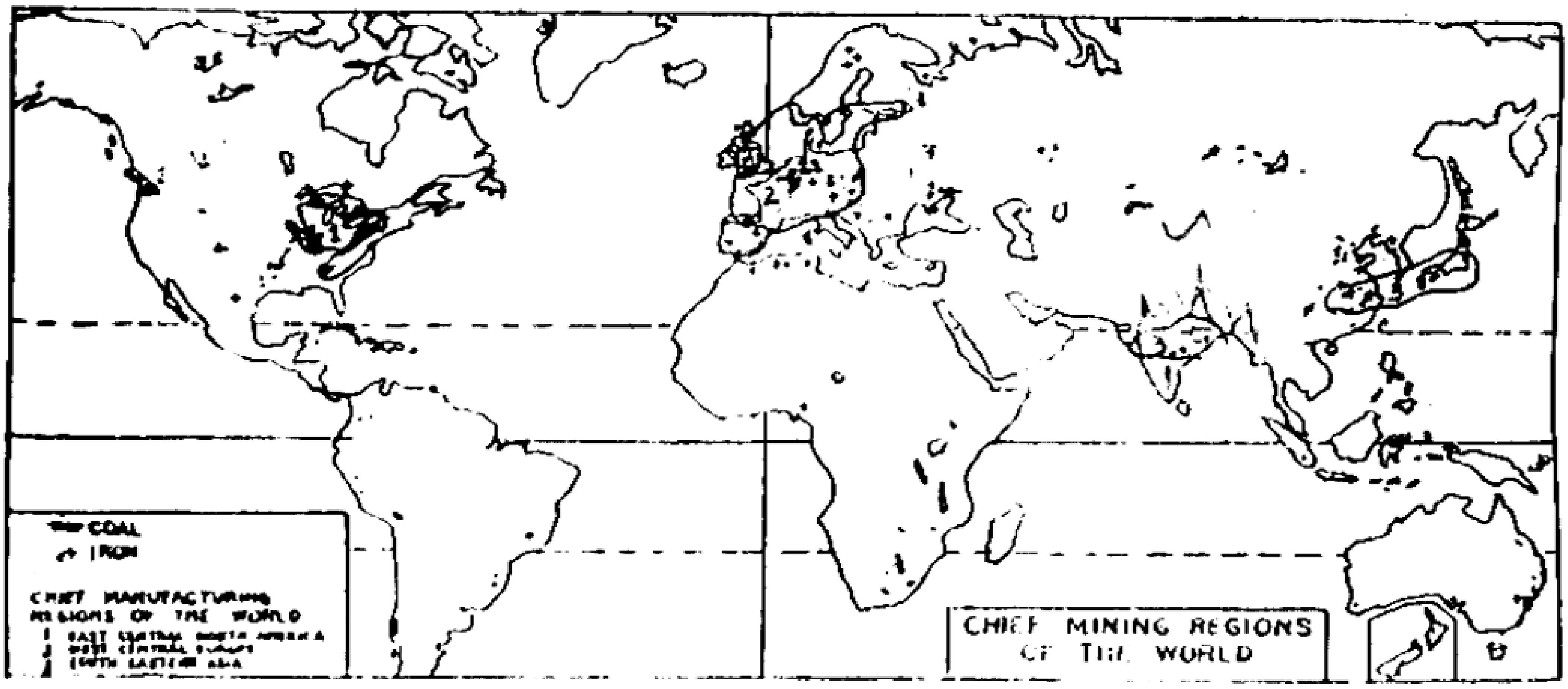
COAL
IRON
CHIEF MANUFACTURING REGIONS OF THE WORLD
1 EAST CENTRAL NORTH AMERICA
2 WEST CENTRAL EUROPE
3 SOUTH EASTERN ASIA
1
2
3
CHIEF MINING REGIONS OF THE WORLD

Fig. 12.

U. S. A. is the greatest iron-producing area in the world, consuming most of its own ore in its industries. The iron field situated at the western end of the Lake Superior in the state of Minnesota, is perhaps the most important iron field in the world. The Southern Applachian states also have important iron fields. U. S. A. produces about $\frac{1}{4}$ of the total iron of the world. Then come France and Great Britain. U. S. A., Britain and Germany collectively claim about ½ of the world total. Other iron-producing countries are Sweden, U. S. S. R., Belgium, Spain and Norway. China and Asiatic Russia (Siberia) have many unworked deposits. The entire southern hemisphere mines less than 2 per cent of the world's iron. Some is mined in Australia near Sydney. In the Union of South Africa the mines lie far inland. Ore is used chiefly in small local industries. Brazil and Chile in South America have large iron reserves, but on account of lack of coking coal, not much is exploited.

Table showing world distribution of iron ore (1937)

Country	Total production	Per cent of total world production
U. S. A. ...	73,251,000 Metric tons	28
France ...	37,772,000 ,,	17
U.S S. R. ...	28,365,000 ,,	16
United Kingdom	10,000,000 ,,	8
Sweden ...	9,100,000 ,,	7
Germany ...	8,522,000 ,,	5·5
British India	1,999,000 ,,	2

France, Spain, Sweden and Norway export a major portion of their iron ore as they have no abundant supply of fuel. U. S. A. exports only about 2 million dollar worth of iron ore every year while U. K., Ireland and Germany practically export no iron ore. France and Sweden alone supply about two-thirds of the world exports of iron ore. Most of the French ore goes to Germany, Belgium and Luxumbourg. Germany and U. K. take most of the Swedish ore. Until recently Spain also used to send her ores to U. K. and Germany, but the trade has been disturbed owing to war conditions.

Copper

Copper was perhaps the earliest metal known and used by Man. It was greatly used in the preparation of bronze.

To-day its utility has tremendously increased owing to the fact that it is a good conductor of heat and electricity. Hardened with zinc, it makes brass.

Copper is also found as an ore but unlike iron, it is not easy to smelt. Copper ore is often transported thousands of miles before it can be suitably smelted. The principal sources of copper are native copper and sulphide ores.

U. S. A. supplies about one-fifth of the world's supplies of copper. The most important copper fields there occur near Lake Superior or in the Rocky Mountains. Canada also produces large quantities specially near Sadbury to the north of the Great Lakes.

Chile, specially northern Chile also produces large quantities. The metal is exported from Iquique and Tocopilla.

The area lying between the Congo and northern Rhodesia in Africa also produces some copper. Most of the Copper mined here is exported to Belgium, South Wales and Germany.

The richest copper mines in Australia lie in the middle west of New South Wales, Queensland and also in Western Australia.

In Japan copper is the most important mineral.

Britain produces only small quantities of copper and much is imported from Canada, Spain and Australia.

The total copper production of the world in 1937 was about 2,200,000 metric tons. The following table gives the percentages claimed by various countries :—

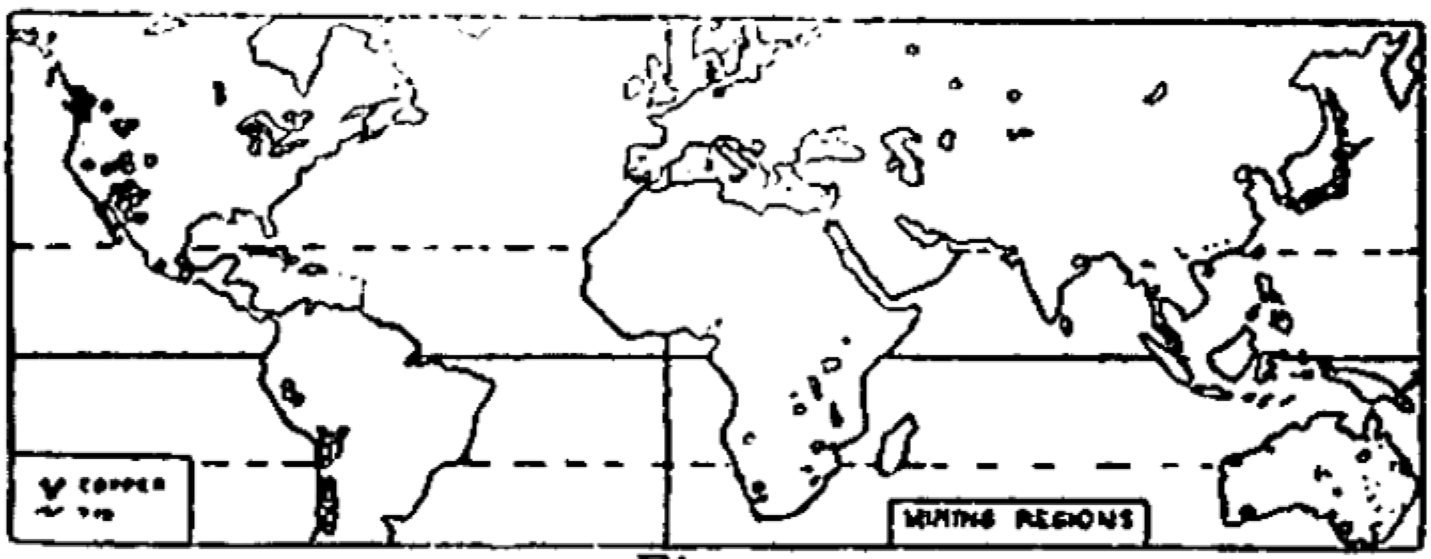

Fig. 16.

U. S. A.	...	30 p. c.
Chile	...	17 ,,
Canada	...	11·4 ,,
Belgium Congo	..	6·1 ,,
Soviet Union	...	4·7 ,,
Mexico	...	1·8 ,,
Peru	...	1·7 ,,
Spain	..	1·4 ,,

Aluminium

Aluminium, like copper is also a great conductor of heat and electricity. Besides, it combines the qualities of lightness, great toughness and durability. Aluminium oxides only very slowly. Aluminium compounds (Bauxite) are very widely spread and are said to form about one-twelfth of the earth's crust. Its importance dates back to only about 50 years. It is worked by electricity.

The bulk of world's supply of aluminium come from U.S.A. and Germany. Britain specially Scotland has important aluminium centres. The following table is quite useful :—

Countries	*Production*	
Germany	118,000	metric tons.
U. S. A.	105,000	,,
Canada	36,000	,,
U. S. S. R.	35,000	,,
France	30,000	,,
Norway	20,000	,,
Italy	19,000	,,
Switzarland	19,000	,,

Its importance for æroplane-construction is great specially in war times.

Lead

Lead is a bluish-grey metal, heavy, soft and fusible. Silver is ordinarily found with lead and as such lead is mined as a by-product of silver production. Lead is used greatly as sheet lead, for munition, piping, alloys and for chemical compounds. Vast quantities of paints are prepared from lead.

The chief lead-producing countries of the world are U. S. A., Australia, Mexico and Canada. North America supplies about half the lead of the world. The world production of lead is estimated at 1,702,000 metric tons (1937).

U. S. A.	423,232	Metric Tons
Mexico	223,678	,,
Australia	238,833	,,
Canada	181,162	,,
Germany	166,100	,,
Belgium	93,804	,,
U. S. S. R.	55,000	,,
Italy	39,000	,,
France	38,000	,,
Spain	30,000	,,

Tin

Tin is had from an ore called tin oxide which is only sparsely distributed. Tin is mostly used for box-making and tin-plating. It is too soft for any other use. When mixed with copper, it forms bronze and gun-metal. It was also known to the old world. But its importance has increased since the development of tin-canning industry. Many substitutes have been suggested, *e.g.*, aluminium, but it is cheaper than all.

The greatest tin-producing region lies in the south-eastern Asia specially Malaya, Siam and Burma. Bolivia, S. E. China and Nigeria are some other important tin-producing areas. See Fig, 16 and 17.

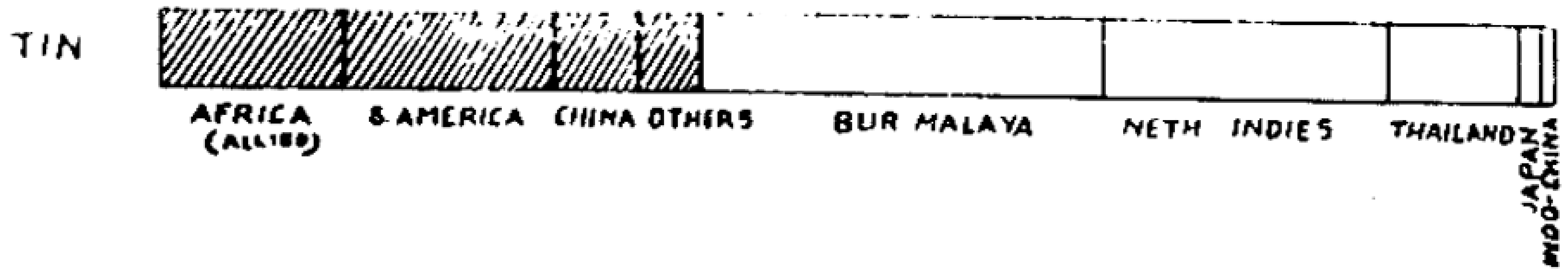

Fig. 17.

Countries	*Production (1935—38)*
Federated Malaya States...	55,000 of metric tons.
Netherlands India ...	27,000 ,,
Bolivia ...	25,000 ,,
Siam ...	13,000 ,,
China ...	12,000 ,,
Nigeria ...	8,000 ,,

All the important steel-manufacturing countries import tin for the manufacture of tin-plate which mean thin iron sheets with tin-coating. U. S. A. is the chief importer of tin because of its canning industry. U. K. ranks second in tin imports, although its figures are about ⅓ or even ¼ of those of U. S. A. Russia and Japan are also becoming important importers of tin as canning is getting important there.

Zinc

Zinc occurs in sulphide ore, blende or sphalerite and is greatly associated with lead, iron pyrites and copper ores. It is used to coat or galvanize iron as a guard against rusting. Zinc oxide is used in white paint ; alloyed with copper it makes brass.

Europe produces about half of the world supplies of zinc. U. S. A. is also a very important producer. The states of Oklahama, Kansas and Missouri combine to form the greatest zinc-producing district. Most of the lead districts of Canada and Mexico also produce zinc. Silesia in Germany is also an important producer. U. S. S. R. (specially Kola peninsula in the extreme northwest) also produces some zinc. Burma and Australia have some zinc-production in their lead-districts.

The world total in 1937 was 1,621,000 metric tons, out of which individual percentages for important countries are given below :—

U. S. A.	...	28·9 per cent.
Belgium	...	18·6 ,,
Canada	...	9·6 ,,
Germany	...	9·5 ,,
Poland	...	6·7 ,,
Australia	...	4·6 ,,
U. S. S. R.	...	3·8 ,,
U. K.	...	3·8 ,,

Manganese

Manganese is used for hardening steel and for chemical and electrical purposes, as well as for paints and varnishes

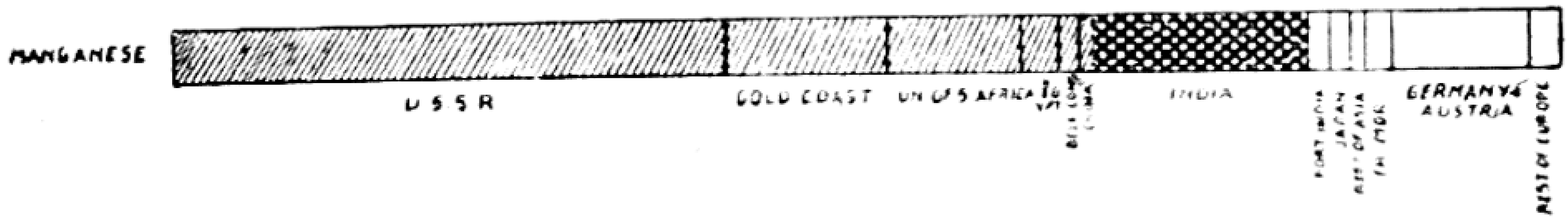

Fig. 18

Nearly all the manganese produced is consumed in the metallurgical industry. Russia, India. Egypt, and the Gold Coast of Africa are the chief producers of manganese. Brazil also produces some manganese and supplies U. S. A. with all of her manganese requirements. British Guiana and Paraguay are reported to be having unworked deposits of manganese.

Russia is the topmost producer of manganese, the chief regions being Ukraine and the Georgian Republic.

India was about 15 years ago, the greatest producer of manganese. Here manganese is mined in Madras, C. P., Bihar and Orrisa, Mysore and Bombay. But now Russia has left her far behind.

Table showing Manganese Production in various countries (1935)

U. S. S. R.	...	2,377,000 metric tons
India	...	641,000 ,,
Gold Coast	...	405,000 ,,
Germany	...	192,000 ,,
South Africa	...	96,000 ,,
Egypt	...	85,000 ,,
Brazil	...	61,000 ,,
U. S. A.	...	51,000 ,,
Rumania	...	20,000 ,,

The important iron and steel manufacturing countries, *e.g.*, U. S. A., United Kingdom, Germany, France and Belgium are also the chief consumers of Manganese.

Nickel

Nickel also adds to the toughness of steel. It is also in great use for coin-making. The province of Ontario in Canada claims about 84 per cent of the total nickel produced of the world. Eight percent is produced by new Caledonia (French) and about 6 per cent by U. S. S. R.,—world tonnage being 79,000.

' Monel Metal ' is an alloy of copper and nickel and is used specially for high pressure steam systems. The use of nickel is also increasing for household purposes.

Chromium

Chromium is used in steel alloys, as well as in dyeing, tanning, and painting. The addition of chromium to nickel steel renders the mixture non-corrosive. The stainless steel blades of knives and other stainless steel products are usually made of this alloy. The following table gives percentages of total production which is about 380,000 tons :—

U. S. S. R.	... 21	per cent of the	world production
Turkey	... 20	,,	,,
Southern Rhodesia	15	,,	,,
Union of South Africa	12	,,	,,
New Caledonia	... 7	,,	,,
Yugoslavia	... 6	,,	,,
Cuba	... 5	,,	,,
British India	... 5	,,	,,
Japan	... 4	,,	,,
Germany	... 3	,,	,,

Tungsten

Tungsten is one of the hardest metals and is in great demand for high-speed cutting tools and for filaments in radio and electric bulbs. China and Burma collectively claim about 60 per cent of the total Tungsten—the world production being about 13,000 tons per year. The United States of America produce very little and import a lot from China.

Table showing percentages of production

China	...	33	per cent of the	world production
Burma	...	21	,,	,,
U. S. A.	...	10	,,	,,
Malaya	...	9	,,	,,
Bolivia	...	6	,,	,,
Argentine	...	3	,,	,,
Indo-China	...	2	,,	,,

Molybdenum

It is used to produce extraordinary hardness in steel. This hardened steel is used for such tools as saws and planning machines. Colorado in U. S A. produces about 84 per cent of the world total—the total production of the world being about 7,000 tons per year. Mexico and Norway claim only about 8 and 5 per cent of this total.

Vanadium

The Vanadium output is exceedingly small—about 2,000 tons per year. It is mixed with steel to produce a high grade product. Southwest Africa produces about half of the total Vanadium—a position which was formerly enjoyed by Peru. Northern Rhodesia claims about 25 per cent and Peru and U. S. A. about 12 per cent each.

Antimony

Only about 32,300 tons of Antimony are mined every year. It is obtained from an ore called 'sulphide of Antimony' (stibnite). It is generally used for hardening other metals and for printers' type metal. China produces about 53 per cent of the total world production, Mexico about 15 p. c., Bolivia about 13 p. c., Germany about 5 per cent, and Algeria also about 5 per cent.

SECTION B

PRECIOUS METALS

Gold

Gold is a very precious metal. It is used for jewellery and for money. It occurs in reefs or lodges generally associated with igneous rocks. A large capital outlay is needed to work gold deposits. Gold can be beaten, without breaking, to a thickness of about $\frac{1}{200,000}$ part of one inch.

It is very soft and has to be alloyed with silver, etc., for use in coinage and arts. Its distribution is fairly wide, but more than half is supplied by the British Empire, chiefly Union of South Africa, Australia, Canada and India. Other important producers are U. S. S. R., U. S. A., Mexico and Phillippines.

Gold is also obtained from placer deposits in alluvial soils, where it is derived from veins farther up the streams. Most gold is obtained from Placer deposits. Alluvial gold is easy to obtain.

The world production of gold is about 1,050,000 kilograms (1 kilogram=82 Troy oz.). The following table shows the production of gold in the chief gold-producing countries :—

South Africa	850,000	kilograms
U. S. S. R.	200,000	,,
Canada	117,000	,,
U. S. A.	116,000	,,
Australia	86,000	,,
South Rhodesia	25,000	,,
Mexico	28,000	,,
Japan	21,000	,,

Silver

Silver is a metal cheaper than gold. Its production is more abundant and its distribution more extensive. It is greatly used for money, and jewellery. Silver is also used for table service, camera films and plates, and surgical instruments.

Though silver is chiefly derived from lead, copper and zinc ores, it is also found native in some rocks.

The world silver production is estimated at about 175 million fine ounces, out of which about 50 per cent is claimed by Mexico and U. S. A. taken together. The following table gives figures for the chief silver-producing countries.

Mexico	70·5	millions	of fine ozs.
U. S. A.	26·1	,,	,,
Canada	16·7	,,	,,
Australia	10·5	,,	,,
Peru	7·5	,,	,,
Japan	6·0	,,	,,
India	6·0	,,	,,
Germany	6·0	,,	,,
Bolivia	4·9	,,	,,
Honduras	8·6	,,	,,

Silver exists chiefly in the western mountains of North and South Americas, in various mountain districts of central Europe, in Eastern Australia (Broken Hills), and in India and in a few small regions of South Africa.

Lately the price-level of silver has shown a downward tendency owing largely to over-production. To check this. Mexico, U. S. A. and Canada concluded an agreement to restrict the output of silver and thus the prices have been sufficiently stabilised.

Platinum

Platinum is rarer than even gold or silver. It is valued for its hardness. It is widely used in photographic and laboratory equipment and in electrical goods. White gold is a mixture of platinum and gold and is greatly used for ornaments.

Russia (Ural mountains) has long been the greatest producer of platinum but only recently, it has been surpassed by Canada. The platinum reserves of Russia are, however, still very huge. Union of South Africa is also a producer of platinum.

Radium

Radium is the rarest of all metals, and is valued for its radio-active properties. Its greatest use is for medical and surgical purposes. Belgian Congo provides almost all the world supply.

Diamonds

The greatest supply of diamonds used to come from India but the scene of action has now shifted to South Africa (specially to the Kimberley area). Belgian Congo, South West Africa, the Gold coast and British Guiana also have some diamond mines.

Other precious stones worth mentioning are Emeralds of Colombia, Rubies of Upper Burma, Sapphires of Ceylon and Opals of Queensland.

SECTION C

OTHER MINERALS

1. *Salt* occurs in a solid form. It is also obtained from sea water. In India more than half the supplies come from sea water. The total salt production of the world is

about 24,800.000 Metric tons out of which about a quarter is claimed by U.S.A. Other salt producing countries are U.S.S.R., Germany, France, India, and Italy.

2. *Building stone* is found everywhere in abundance and in great variety. Limestone, slate, marble, granite and sandstone are the main types. The best marble comes from Italy. Granite is quarried chiefly in England, France, Canada and Sweden. England and U. S. A. also produce slate.

8. *Sulphur* is a yellow-coloured, brittle soft-stone and melts into an amber-coloured liquid, when heated up to 226°F. It is used mainly for the manufacture of gun-powder and chemical compounds. About 70 per cent of world's total is supplied by U. S. A., 18 per cent by Italy and 4 per cent by Japan. Spain, Norway, Germany and China are other producers. Copper is produced as a by-product.

Other miscellaneous minerals include, graphite, Gypsum, Asbestos, Phosphates, Nitrates and Glass-sand.

CHAPTER IX

GEOGRAPHY OF INDUSTRIES

SECTION A

Factors Necessary for the location of Industries

Power is perhaps the most important factor in the establishment of an industry because cheap and regular supply of power is the greatest need of a modern manufacturing industry. It is due to this 'pull' exercised by power that most of the industries of to-day are situated near coal-fields, oil wells or near sources of Hydro-electric power. Oil and water-power can be transported to quite long distances and industries may in future be situated quite far away from the sources of power. Coal is as yet the best and the cheapest source of power and as such all industries are located near coalfields. The best examples of this *coal control* can be seen in Germany and Great Britain where the areas around the coalfields are also the best industrial areas. It is cheaper to take the machines and the raw material to coal than to take coal to the machines and the raw material. The cotton mills of Lancashire are situated near Yorkshire coalfields while cotton comes from U. S. A., Egypt and India. The Rhur valley factories get their iron from Spain, Sweden, Norway, and France. Examples to illustrate this could be easily multiplied.

Generally speaking, therefore, sources of power specially coal seem to have attracted many manufacturers, a phenomenon which is referred to as "Centralization." As has been mentioned, the modern trend would appear to be towards "Decentralization," for with the increasing use of oil and electricity, power can be easily and quickly transferred to any particular region when required.

Raw Material is an essential requirement of every manufacturing industry. It may be locally available or raw material may be transported to the places of need.

In the case of perishable raw material, it is essential that the factories be situated nearby. The same may be the case if the raw material is very bulky or if transport involves high expenditure. Many industries are established at ports (*e.g.*; Jute industry at Dundee and leather industry at London) because of the importing facilities in the case of raw material and exporting facilities in the case of finished goods.

The cotton industry of Lancashire is where it is also because excellent harbour and shipping facilities have made possible cheap raw cotton imports from overseas. On the other hand, the cotton industry of southern U. S. A. is due to the existence of abundant raw cotton in the surrounding area.

Transport facilities and Markets are of equal importance. An industry can flourish only if it is connected by means of cheap and efficient transport facilities with its suppliers of raw material and with its customers of the finished goods. Transport should be cheap otherwise it may affect the price of the commodity adversely. There should be ready markets so that the mills may be kept running. There are many industries that develop near markets and there are others that have been established mainly to cater for remote markets, for instance the cotton mills of Lancashire make cloth chiefly for India and the Eastern colonies.

Means of transport play an equally important part. Many regions have developed rapidly mostly because of transport developments. Many regions are as yet ill-developed because of the lack of transport facilities *e.g.*, China only lacks transport, it already has raw material and power.

Labour supply :—Cheap and abundant labour is also an important requisite of a manufacturing industry. Labour should essentially be skilled and well-versed in that particular work. The cotton industry of Lancashire owes much of its development to the presence locally of a good supply of skilled labour. The rise of Japanese industries is due greatly to the cheapness of its labour. Absence of labour may be the main cause of the decline of a particular industry.

In some industries **climate** also plays an important part. Cotton industry for example can be carried on only if the climate is humid. Lancashire has such a climate. Japan too is climatically suited for cotton industry. The same is the case with Bombay. Science has, however, tried to do away with this condition by the invention of artificial humidifiers.

Besides the above, there are many other factors like

Rates, Tariffs and Bounties that affect the establishment of an industry besides of course the presence of 'capital' a factor which is common to all enterprise. *Official encouragement and discouragement* also go a long way in the location of a particular industry. A stable administration is also an absolute necessity for industrial progress.

Once an industry is established at a place, it continues to be there in spite of the fact that one or more factors may have ceased to be active. This is greatly due to human factors – "for money has been spent on the establishment of works, markets have been developed for the product of the factories and specialised skilled labour is abundant." Such a phenomenon is called "Geographical Inertia."

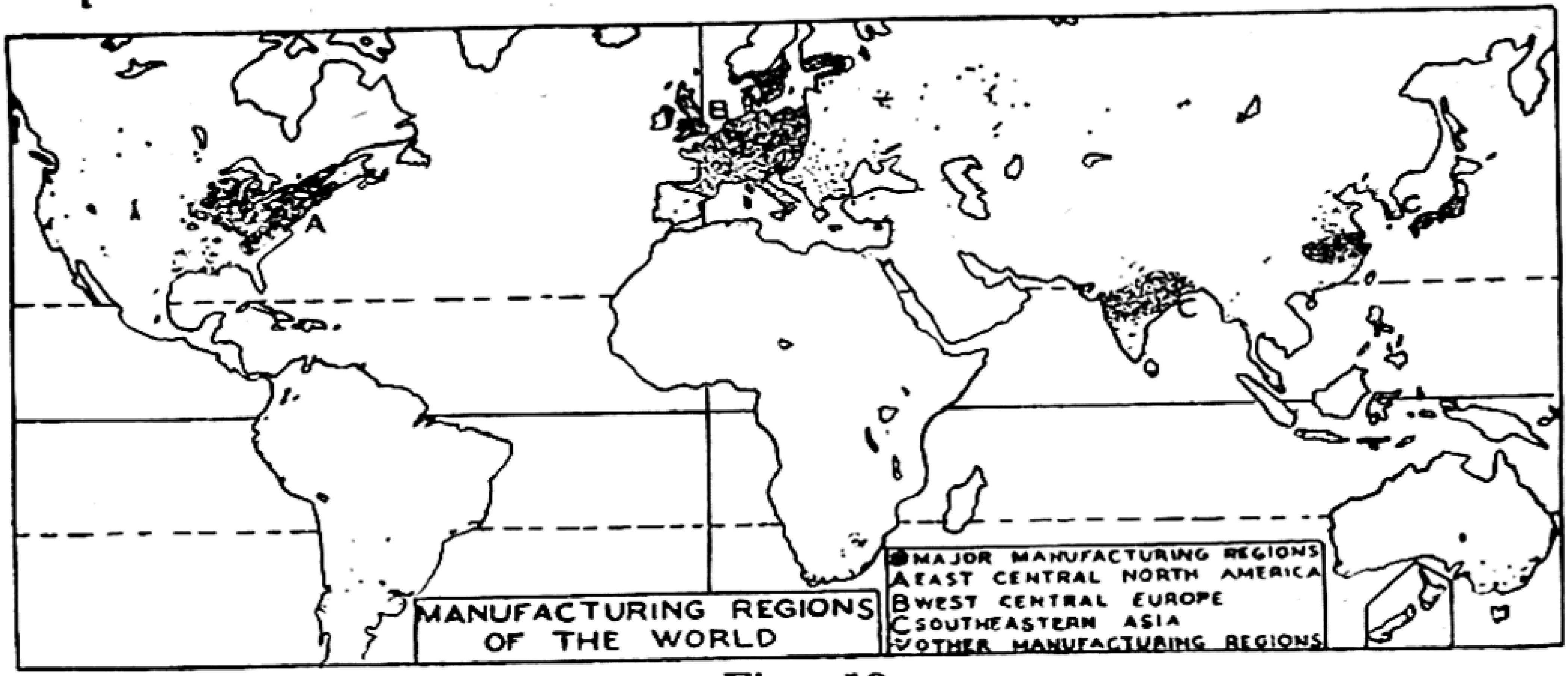
A
B
C
MANUFACTURING REGIONS OF THE WORLD
● MAJOR MANUFACTURING REGIONS
A EAST CENTRAL NORTH AMERICA
B WEST CENTRAL EUROPE
C SOUTHEASTERN ASIA
OTHER MANUFACTURING REGIONS

Fig. 19.

The figure shows the geographical distribution of manufacturing regions of the world. A, *i.e.*, the East Central North America and B, *i.e.*, West Central Europe are specially suitable for industries owing to an abundance of coal and other means of power and transport facilities both internal and external. C, *i.e.*, South Eastern Asia is not such an important area except for Japan.

SECTION B

GEOGRAPHICAL DISTRIBUTION OF INDUSTRIES

Major Industries

The following industries may be called 'Major.'

1. Iron and Steel.
2. Cotton.
3. Woollen.
4. Silk.
5. Paper and wood-pulp.

Iron and Steel

Iron and steel industry is the basic industry that supplies industrial tools and machinery that make other industries possible and also supplies the modern means of transports, *e.g.*, railways, motor-vehicles, etc. In a way we can say that iron and steel industry is the very foundation of our industrial development and as such it deserves great attention.

The first step in the industry is the mining and carrying of ore to the smelting furnaces.

Mining and carrying of coal and limestone to the fur naces is equally important. The next step involves the refining of iron into what we call *pig-iron*. Pig iron may be exported or may be further refined into steel or goods may be manufactured directly out of it. While making steel certain alloys may be mixed with molten iron to give it the finish and the required characteristics. The most important alloys are nickel, aluminium and zinc.

Water supply is important at all the stages of iron manufacturing and therefore proximity of water is an absolute necessity. Perhaps it is also due to this reason that nearly all iron steel centres are situated near water-courses.

Power plays the chief part in locating the industry. Besides being cheap it should be capable of producing a very high amount of heat (about 3000°F). Coal meets these requirements and, therefore, most of the iron factories are near coal mines and not necessarily near iron mines. Sometimes ore is brought from long distances.

There are 2 important methods of making steel :—

1. The Bessemer Process.
2. Open Hearth process.

In the first impurities like carbon are removed by passing wind through molten iron, while in the second method a different kind of furnace is used and the wind passes via the upper surface of the molten matter and not through it.

The first method is mostly used in Germany where ½ of the steel is made in this way. In U. S. A. only 12 % and in Britain only 5 % of steel is made by this method.

The second method is more important in U. S. A. and Great Britain where more than 80 % of steel is made by this method.

The world production of iron and steel has tremendously gone up during the last three or four decades.

Pig Iron :

1900	world production	40	million ton.
1913	,,	78	,,
1929	,,	97	,,
1938	,,	110	,,

Steel.

1900	world production	28	million tons.
1913	,,	75	,,
1929	,,	118	,,
1938	,,	125	,,

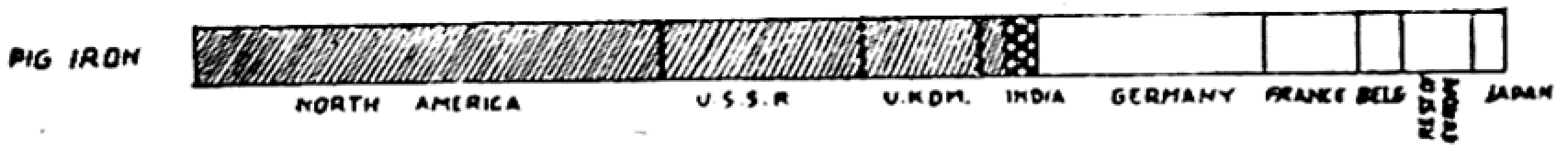

Fig. 20.

U. S. A. is the biggest producer of both Pig iron and Steel and claims about ½ of the world production. Then come Germany and Great Britain.

U. S. A. (Steel) ...	55	million metric tons.
,, (Pig iron) ...	54	,,
Germany (Steel) ...	14	,,
,, (Pig iron) ...	12	,,
Great Britain (Steel)...	10	,,
,, (Pig iron) ...	9	,,

U. S. A. and Western Europe make 90 % of world's iron and steel and it is but natural that these two regions are the chief industrial regions of the world.

In Europe there are three main iron and steel centres.

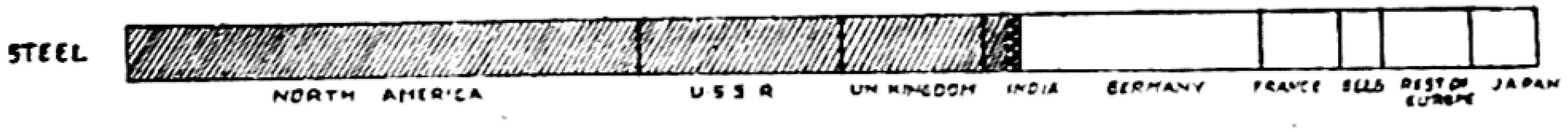

Fig. 21.

1. Great Britain.
2. Silesia.
3. Lorraine.

All the above regions are also important for coal mining. Great Britain and Ruhr-lorraine have the advantage of local iron mines. Silesia mostly uses imported ore.

About 70 % of ore used in German mines, is imported chiefly from Sweden, France and Spain.

Great Britain also imports huge quantities of ore from Spain and Scandinavia. It has got the advantage of having most of its industrial centres near ports.

The following regions are important in Great Britain.

1. S. Wales.
2. North Lincolnshire.
3. North West Region.
4. Derby.
5. Nottinghamshire.
6. Crewe.

Belfast in Northern Ireland is important for shipbuilding. Both ore and coal are imported.

In U. S. A. there are five chief iron and steel-manufacturing centres.

(1) The Pittsburgh area-where several rivers meet and where both coal and iron can be brought quite easily ;

(2) The Birmingham-Albama district ;

(3) The Lake Erie district, including Buffalo, Cleveland and Detroit ;

(4) The Lake Michigan district including Gary, Indiana, Illinoes and South Chicago ;

(5) The Baltimore and Eastern Pennsylvania district.

Cotton Industry

It is one of the most important textile industries closely followed in importance by the woollen and silken industries. It is important because it supplies clothing for about 90 % of the people of the world. It occupies a unique position in the economy of many countries, *e. g.*, U. S. A. and Great Britain as it supports a very large number of people and it is not surprising to see that it has been given the titles of the ' King ' and ' Bread ' in these countries, respectively. Japan is what it is to-day only because of her cotton industry. It has beaten all other countries at least in the matter of cheap cloth. The development of this industry is however a recent affair. Its size was quite insignificant in the 17th century. During the 18th century it was mostly carried on as a cottage industry. It was only in the 19th century when proper spinning and weaving machines had been invented that the industry made tremendous progress. The development of power resources also put it on a very sound footing and gave it an international colouring. Unlike many other industries the proximity of raw material is not a very serious factor. In determining the geographical location of factories, climate plays an important part. A high percentage of humidity is essential. Cheap, abundant and skilled labour is also a necessity. Power, ofcourse, is equally important.

Another limiting factor is the demand for the particular type of cloth manufactured. For example not very long ago the British mills used to manufacture special items for the Indian market and as soon as the demand decreased it caused a general unemployment in the mills concerned.

For finishing and dyeing purposes the presence of soft water is also essential, (*e.g.* the waters of north east U. S. A. are suitable for these purposes while those of the Southern Region are unsuitable. Hence the production of rough cloth in the south).

The invention of humidifiers has to some extent limited the climatic control over the industry. Most of the mills in U. P. and the Punjab make use of this invention.

The world distribution of cotton industry is as given in the table below :—

Country	Spindles	Raw cotton consumed
Britain ...	35% (of world spindles)	20% (of the world consumption).
U. S. A. ...	28% ,, ,,	27% ,,
Germany ...	7% ,, ,,	8% ,,
France ..	6% ,, ,,	5% ,,
Japan ...	8% ,, ,,	5% ,,
China ...	2% ,, ,,	7% ,,

Textile manufacturing in North America originated in southern New England—to-day one of the leading textile centres of the world. Prior to 1790, the industry used hand power only, but in 1790, Samuel Slater (who came from England with a knowledge of English textile machines), built the first textile factory in the United States. Invigorating climate, moist atmosphere, abundance of water for power and for cleansing and bleaching the cloth, the growing markets of New England and of New York, access to the raw cotton of the South, energetic and skilful workers—all favoured the development of the cotton manufacturing industry in New England.

As the industry developed, New England inventors improved textile machines, labour became more skilled, and transport by sea and by land increased the sources for raw material and the markets for the increasing output of the factories. Until recent years, New England was the chief cotton manufacturing centre of the United States.

Cotton manufacture in the Southern Appalachian district (including the lower mountain slopes and plateau areas of North Carolina, South Carolina, Georgia and Alabama) began about 1880 and has grown steadily ever since. This district now surpasses New England in the total number of spindles, the amount of cotton consumed, and also in the total value of textile goods manufactured.

The southern district has the advantage of being near raw material. It equals New England in water power and availability of coal and has lower labour costs. Taxes are lower in the South, and northern capital has now been invested in developing the textile industries of the South. The greater skill and soft water available in New England enable it to produce finer and more expensive cotton fabrics. Some cotton factories have also been built in the western part of the Cotton Belt.

Europe consumes 42 per cent of the world's raw cotton; the chief cotton-manufacturing countries of Europe are Great Britain, France, Belgium, the Netherlands, Germany Czechoslovakia, Switzerland, and Poland. Western Russia and the Po Valley of Italy also carry on some cotton industry.

The Lancashire area in England is one of the most important cotton manufacturing districts of the world. As has been said before it has coal mines nearby, climate is humid, skilled labour is available and transport is well developed. The figure illustrates very clearly the geographical factors involved therein.

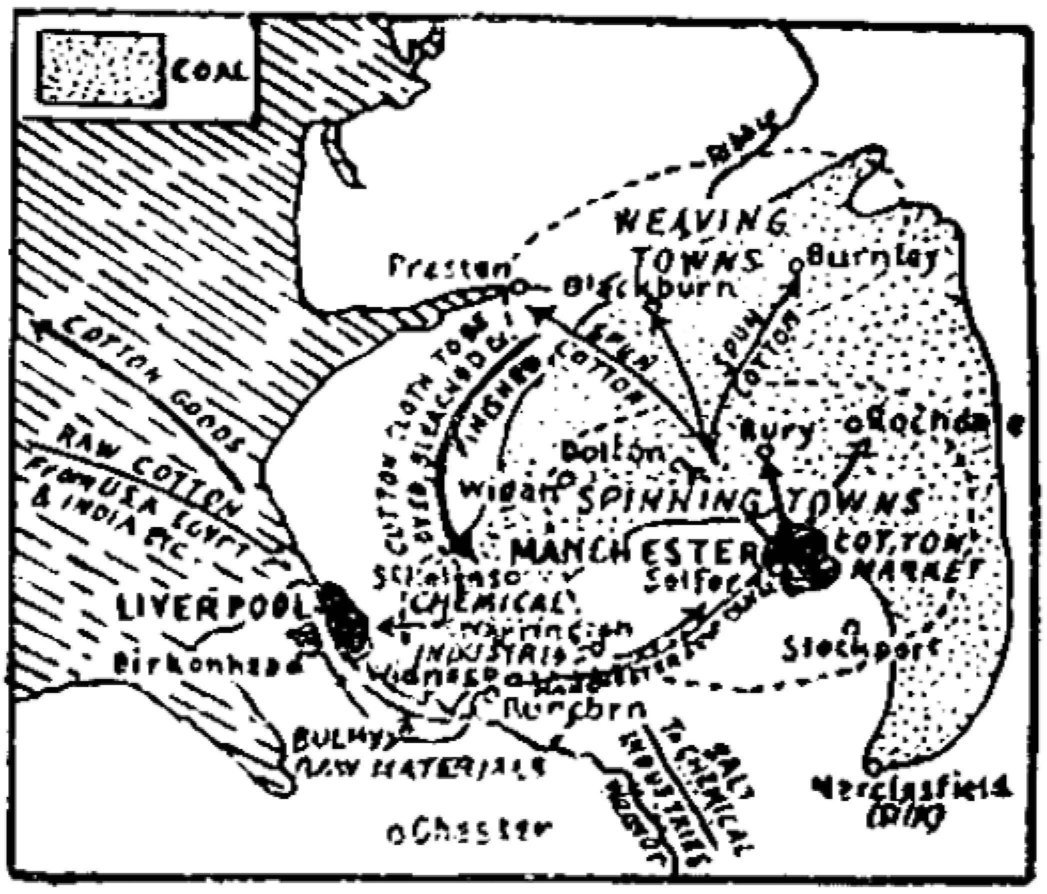

Fig. 22. The Lancashire cotton districts.

North-western India, Japan, and South-eastern China, together manufacture 26 per cent of the world's cotton.

India and China grow their own cotton, while Japan imports cotton from India, China and the United States.

In India there are about 350 cotton mills—about 81 are in Bombay, the same number in Ahmadabad and the rest in Madras, C. P., the Punjab and also in U. P.

North America manufactures 28 per cent of the world's cotton. This leaves 4 per cent to be distributed amongst the mills of South America, Africa and Australia. In these three continents, south-eastern Brazil is the leading cotton manufacturing area.

Woollen Industry

The woollen industry is in some ways older than the cotton industry. In England and America woollen industries were flourishing when nobody even knew about cotton. Formerly the industry was located near wool-producing areas and it is even true to-day in some places, *e. g.*, the woollen industry of Great Britain and that of France is situated near regions which are also important for their production of wool. But to-day the production of wool has comparatively a slighter affect on the location of the industry. About four-fifths of wool is produced in the Southern Hemisphere (please refer to the section on wool) but most of the important woollen factories are situated in Europe and U. S. A. They, taken together, consume about ¾th of the total wool production·

Water supply is a very important factor in the location of the woollen industry. Suitable, soft water is needed in all the processes of the industry specially for " scouring of wool and for dyeing and fulling purposes." Now most of the looms are worked by mechanical power and as such the presence of fuel nearby is of equal importance. Skilled labour is also an absolute necessity.

It may be interesting to know that almost no wool is manufactured between the tropics for the simple reason that owing to warm climatic conditions, cotton is used for clothing and not wool.

Europe is the most important continent in the manufacture of wool and utilizes about ⅔rd of the world's mill consumption of wool. West Central Europe extending from the United Kingdom to Western Russia is the chief wool manufacturing area. A lot of wool used is imported from distant lands. The cool, damp climate is another advantage. The water and transport conditions in this belt are also excellent.

In U. S. A. the industry is widely scattered. Mills may be found in almost all the states, but most of them have small output. The chief concentration, however, is on the Atlantic sea-board specially in New England. Wool is had from the wool-producing areas of the west where the number of factories is very small.

Japan is quite an important wool manufacturing country. She gets most of her wool from Australia.

In India too, there are a number of mills, situated specially in the northern area.

Silk Industry

More than 86 per cent of the world's raw silk is produced in Japan and China but they manufacture only about 20 per cent of the world total of silk goods. U.S.A. and Europe claim about three-fourth of the total manufactured silk.

Nearness to raw material is apparently a very unimportant factor in localising silk industry. U. S. A. does not produce any silk but manufactures about 50 per cent of the silk of the world. The chief silk manufacturing centres lie in the vicinity of New York city—Paterson and New Jersey being the chief centres. Most of the raw silk comes from Japan and China. U. S. A. is the largest consumer of silk goods and imports a large quantity of the same.

Europe claims about 25 per cent of the modern silk industry. The chief concentrations are in the Po Basin in Italy, in the Swiss valleys and near about Lyons in the Rhone valley in France. Milan is the main silk centre in Italy. Saxony and the Rhine valley in Germany also have some mills. In United Kingdom the industry is found along with the woollen and cotton centres on the borders of the Penines. Besides consuming their own raw silk (specially Italy and France) a lot is imported.

In Japan the silk mills are mostly situated in the north of the Tokyo Plain industrial area.

Rayon or *artificial silk* was first prepared in the later years of the last century. Rapid and extensive rayon development dates back only to the year 1920 when some technical developments were brought to light and they changed the whole outlook of the industry. More rayon is now produced than silk. The industry is concentrated in the industrial areas of U. S. A., Japan and Europe. Japan is the biggest producer and exporter of rayon. U. S. A. and United Kingdom are the largest importers. In Europe the countries worth mentioning are Italy, United Kingdom, France, Germany, and Switzerland. Australia also produces some rayon.

The following table shows the rayon production in various countries (1937) :—

Japan	...	149,687 metric tons
U. S. A.	...	141,632 ,,
United Kingdom		54,296 ,,
Germany	...	49,896 ,,
Italy	...	47,310 ,,
France	...	21,772 ,,
Netherlands	...	10,297 ,,

Paper and Wood-pulp Industry

A very important industry associated with lumbering is making wood-pulp which is used chiefly in the preparation of paper and cellulose. Formerly paper was not much in demand and rags of all sorts were used in its preparation. Now the demand for paper has tremendously increased and 'Alfa' (or esparto grass) and wood-pulp are used for paper manufacture. Paper was invented in China in A.D. 105.

Both deciduous and coniferous trees are used for making wood-pulp ; the best varieties of trees used for making pulp are spruce, fir and pine.

North America and Europe produce about 85 per cent or even more of the total pulp. U. S. A., Canada and Sweden are the largest producers. Figures for various pulp-producing countries are given below :—

U. S. A.	...	4,400,000 metric tons
Canada	...	3,300,000 ,,
Sweden	...	2,900,000 ,,
Germany	...	2,100,000 ,,
Finland	...	1,500,000 ,,
Norway	...	800,000 ,,
U. S. S. R.	...	500,000 ,,
Japan	...	300,000 ,,

Pulp factories are more likely to be situated in areas where water power is found nearby and where cheap and efficient means of transport exist. Logs are usually brought down by rivers.

The regions important for the production of pulp are also important for paper. The cheap variety of paper is made from *mechanical pulp* which is had by grinding the chipped logs of wood in water ; while *chemical pulp* is used for better varieties of paper. The latter variety of pulp is purer and is obtained by boiling the wood with alkaline or acid reagents.

Some paper is also made from rags and grass but its quantity is insignificant when compared to the paper prepared from pulp. The following table including all varieties of paper, gives the country-wise production of paper.

U. S. A.	8,800,000	metric tons
Canada Germany	2,700,000	,,
Great Britain and Ireland	2,000,000	,,
Sweden	700,000	,,
Finland Russia	400,000	,,
India	50,000	,,

Minor Industries

1. *Linen* is made from flax fibres grown in temperate latitudes. It is reported to be the oldest of all textile fibres. It is also much more durable than cotton. Linen is, however, much more expensive.

Europe produces almost all fibre flax and also manufactures most of the world's linen. Belgium and Ireland are the leading linen manufacturers. England, Poland, U. S. S. R. and the Baltic states are some of the other linen-producing countries. Special linen goods are prepared in Germany, France and Czechoslovakia.

2. *Leather* is the name given to chemically treated hides. The process is called *tanning*.

Leather-manufacturing is widely distributed and ordinarily every country has its own leather works and supplies its own leather requirements. U. S. A., however, is the most important leather-and-leather-goods-producing country. The Prairies supply the hides and the forest supply the tanning bark. She is also the greatest consumer of leather and leather goods. Philadelphia is the greatest leather-manufacturing centre of the world and specialises in Chrome leather.

In Germany the industry is also very important. She is conveniently situated to collect all material. France is another important country in this respect. Great Britain exports a lot of boots and shoes and her harness and saddlery are also very famous. Leeds, Leicester and Northampton are the chief centres.

3. *Glass* is an item of everyday use and is obtained by melting, mixing and fusing a number of ingredients like potash, soda, lime and red lead. This industry is mostly located near a coalfield and in the vicinity of highly developed chemical industries. Much scientific development has taken place in glass manufacturing specially in Germany and England, countries that produce high quality glass and glass products. U. S. A. leads in the total production of glass but her glass is mostly of low quality and she has to import a lot of good quality glass from outside. Belgium is famous for its looking-glass. Lamp chimneys and coloured glasses are famous in Czechoslovakia (Bohemia and Moravia).

4. *Pottery and Earthenware* are prepared with clay of various types. In U. S. A. the chief pottery centre is Preston in New Jersey. The Porcelain industry is largely carried on in England (Worcestor), Germany (near Dresden), France (near Paris), Italy (Majolica) and Czechoslovakia (Carlsbad). In China the industry has been long established and her wares are valued all the world over.

5. *Chemical industry* is essential in the modern era as it supplies chemicals like caustic soda, chlorine and sodium carbonate for use in various other industries more specially in the textile industries where chemicals are urgently needed for the finishing of textile fabrics. Salt and lime are the factors that greatly affect the location of the industry. Some kind of chemical activity is present in nearly all the industrial areas but the chief centres are Cheshire in England, Alsace in France, Strassfort in Germany and places in North Eastern U. S. A. The chemicals occupy quite an important place in inter-national trade, the chief producers also being the chief exporters.

6. *Flour milling and meat packing* are important in most of the agricultural and animal-grazing areas. Flour milling is extensively carried on in U. S. A. and Canada and most of the centres lie in wheat-producing areas—Minneapolis being the chief centre. Another big centre of flour milling is situated in Northwestern Europe. In nearly all other countries flour-milling is widely scattered, the greatest concentrations being in the wheat-producing areas of India, South America, Australia and Southern Africa.

Meat packing has enabled meat to be consumed very far away from the place of its origin. The packing centres are near the areas of livestock production as it is not commercial to transport animals to the factories. The industry has met its greatest development in U. S. A. where the corn belt is the chief meat region. Chicago is famous for its meat-packing industries. Cincinnati is another equally important centre.

The Southern Hemisphere exports huge quantities of meat because the temperate grasslands there (specially in Argentine) have large surplus of meat. Argentine claims about half of the world's beef exports. New Zealand leads the world in Mutton production.

Denmark and Holland specialise in the production of bacon and send large quantities to Britain.

CHAPTER X

GEOGRAPHY OF TRANSPORT

Transport is an essential part of modern life when so much economic and commercial activity is in evidence. Without quick and cheap means of transport, modern civilization may soon be paralysed. Transportation is carried on by land, sea and air; and we shall study this topic under these very headings. Inland water ways may present only restricted means for navigation.

1. *Land transport.*—(*a*) The *human porter* provided the first means of land transport. He is still the main means of transportation in the mountanous regions of South America, Africa and Asia. In Central Africa, China and Japan men are still employed to carry loads to short distances as beast of burden are very few. Human transport is, however, very expensive and slow and can be used only for short distances. The cost of carrying goods by sea to a place about 8,000 miles away is only about one-third of that involved in carrying it 150 miles by human transport. This mode of transport is, however, of great importance in regions where there are no roads or railways.

(*b*) Almost everywhere *domestic animals* are used as beasts of burden. Horses are in extensive use in the regions of intermediate climates; cattle specially oxen, are used in agricultural and cattle-raising lands. In the dry regions of Asia and Africa camel is the chief means of transport. In the forests of Siam, Burma and India, elephants are used for carrying goods specially timber. Reindeer in Lapland, Ilamas in the Andes (South America) and dogs in the far North are other important examples of animal transport.

Wheeled carts are usually attached to these beasts of burden. The great advantage of these carts is that they can even go on ‘ kachcha ’ roads and tracks.

(*c*) *Road Transport.*—The introduction of automobiles and other vehicular traffic has brought about a revolution in the art of road-making which not very long ago was a very haphazard and quite an unscientific affair. The development has been both in the mileage of roads as well as in the technique of road-making.

Roads are to-day an important feature in every commercial country. At many places roads have come in direct conflict with railways both in the matter of passenger and goods transport so much so that at places they have practically monopolized short-distance traffic. Most of the countries are to-day served by a net work of roads. The following table shows the total of highways in various countries and also show how many miles of roads serve every 1,000 sq. miles of area.

Country	Total of highways		Mileage per 1,000 sq. miles of area.	
U.S.A. ...	3,065,254	miles	1,031	miles
U.S.S.R. ...	1,682,109	,,	204	,,
Japan ...	594,626	,,	2,028	,,
Australia ...	468,251	,,	157	,,
Canada ...	409,124	,,	118	,,
France ...	406,090	,,	1,909	,,
British India ...	277,471	,,	49	,,
Germany ...	216,674	,,	1,917	,,
Great Britain ...	177,347	,,	1,884	,,

What actually matters is not the total mileage but (1) how roads are distributed according to the area and population and (2) the quality of roads. Japan leads the world in this respect as she has about 8 miles of roads for every one square mile. U.S.A., because of its extensive area occupies a low position in this respect.

The network of highways is the densest in eastern U.S.A. and south-eastern Canada. Nearly all centres of population, industry and trade are connected by highways.

In Europe the densest network of highways is situated in the west central region.

Japan has a very dense network of roads ; many roads, however, are not improved roads.

Some idea of the extent of road traffic may be had by realizing that to-day U.S.A. has about 29,400,000 motor vehicles (more than half the world's total), roughly 1 vehicle for every four persons. In Great Britain there are about 2,418,728 vehicles, *i.e.*, about one for every twenty persons. The following table gives the number of motor vehicles possessed by various countries.

U.SA.	...	29,400,000	vehicles
Great Britain	...	2,418,728	,,
France	...	2,192,471	,,
Germany	...	1,564,600	,,
Canada	...	1.306,139	,,
Japan	...	175,761	,,
Australia	...	749,753	,,
British India	..	105,160	,,

Tramways were introduced to reduce the wear and tear of roads by reducing the friction between the wheels and the ground. Originally parallel lines of smooth stones were laid along a road and then as an improvement they were replaced by metal rails. Tramways were first drawn by horses and horse tramways are still in use at many places specially in mining areas. Now the electric tram is in vogue and forms an important part of urban transport.

(*d*) *Railway ;* For quick, cheap and efficient transportation over long distances on land, railways are the best means of transport and to-day they are spread throughout the civilized world—Afghanistan is, perhaps the only country in the modern world, that does not possess even a mile of railway.

Topography controls the distribution of railways in a very obvious manner. Railway gradients must be as easy as possible, if speed and efficiency are to be maintained. This has resulted in the construction of embankments and boring of tunnels through mountain ranges. Wide stretches of water have been mostly bridged over and in the cases of very wide stretches like the Str. of Dover, the train-ferry system has been evolved. In this system train-ferries are used for the transfer of whole trains across the water-in-between. This system has long been in existence between Denmark and Sweden and was not very long ago established between England and France *via* Dover—Dunkerque.

The mileage of railways in various countries is given in the following table.

U.S.A.	...	241,818	Miles
U.S.S.R.	..	52,081	,,
Canada	...	43,307	,,
India	...	39,835	,,
Germany	...	33,704	,,
France	...	27,860	,,

Australia	...	27,180	,,
Brazil	...	20,548	,,
Great Britain	...	20,170	,,
Japan	...	14,248	,,
Union of South Africa	...	13,855	,,

The largest network of railways in the world is found in East Central North America. U.S.A. has about one-third of the total railway mileage of the world and more than 75 percent of this is situated east of 100° meridian. The reasons for this concentration are obvious—the great industrial and commercial development of the region.

In Europe the density of railway lines is more uniform being somewhat higher in the west central regions. In U.S.S.R. the network is gradually developing.

In no part in Asia, even in the Southern and Eastern regions, the density is even near that of the above two regions. The greatest concentrations, however, are found in Japan, India, and Java.

In the southern hemisphere the railways, are situated only in the few temperate and sub-tropical regions where some human activity is in evidence. The greatest mileages and the densest distribution lies in Argentine, Uruguay, eastern Brazil and Murray—Darling Basin.

Outside the concentrations mentioned above, railway transportation is mainly confined to a few trans-continental rail-routes or relatively short lines. The main trans-continental routes are (consult a good atlas for their relative position) :—

North America ; (*a*) The Canadian National Railway (*b*) The Canadian Pacific Railway (*c*) The Great Northern Railway (*d*) The Northern Pacific Railway (*e*) The Union Pacific Railway (*f*) The Western Pacific Railway and (*g*) The Southern Pacific Railway.

South America : (*a*) The only trans-continental railway runs from Buneoos Aires *via* the Pampas to the Andes and thence it descends through many passes and tunnels to Valparaso on the Pacific coast.

Eurasia : (*a*) The Orient Express route connecting Paris with Istanbul *via* Vienna, Budapest und Belgrade (*b*) The Trans-Siberian Railway connecting Vladivastak on the Pacific coast of Siberia with Moscow and Lenningrad in European Russia. With the completion of the Hankow-Canton line in 1936, it is now possible to go to Canton in China from Calais in France by rail. (1) The Trans-Caspian Railway connects central Asia with European

Russia. (*d*) The Baghdad railway was planned to connect Baghdad and Mosul with Berlin. Now, however, it runs from Kenya on the west to Nisbin on the east-having a branch line connection with Alexandretta and Damascus, from where a line runs to Mecca and a second proceeds to the Nile valley crossing the Suez canal at El Kantara.

Africa : (*a*) The 'Cape-Cairo' railway was planned to connect South Africa with Egypt, but it has not yet been possible to fully work it out. At present, however, one may go to Khartoom from the South partly by railway and partly by road. From Khartoom he may go to Wadi Haifa by rail, then to Shellal by river and finally from Shellal to Cairo by train.

Australia : (*a*) The West-East line starts from Perth in Western Australia and goes to Adelaide *via* Kalgoordie and thence to Melbourne and Sydney. (*b*) The proposed north-south line has not yet been fully constructed. The Southern portion is, however, complete.

(*e*) *Inland Water Ways :* Rivers and other inland water bodies were used for transportation even by the earliest man because perhaps of the cheepness and ease of this made of transport. Rivers were the world's earliest highways and nearly all old civilizations were centred in river basins. All the important towns of the world were situated on river banks, *e.g.*, London on the Thames, Cairo on the Nile and Delhi on the Jumna. However, with the invention of bigger boats and vessels, most of them have lost much of their importance. But in many regions where rivers are navigable, river transport still forms an important mode of transport. Many navigation canals have been constructed to connect rivers and thus a sort of continuity has been manifested.

The water-ways of North America specially those in U.S.A. and Southern Canada are important. The Mississippi and the St. Lawrence form the two great navigable river systems. The great drawback in the Mississippi system is that it only allows north-south traffic while the trend of the general movement is from west to east, to the busy Atlantic coast.

The *great lakes* through which the St. Lawrence flows could be favourably compared to the Mediterranean sea in the matter of transport. Large vessels can easily use them. Falls like the Niagra have been avoided by canals and thus a long useful 'highway' can be used. The lakes connect the agriculturally rich regions of the west with the industrial regions of the east. The traffic on the Soo canal joining the lakes Superior and Huron is greater than on either the Panama or the Suez canal. The traffic on this water-way is, however, closed for a couple of months during winter as the waters are frozen and the mouth of the river is ice-blocked.

The inland water-ways of Western Europe are also highly developed. Several canals have been constructed to connect various centres on different rivers. The Rhine is the most important unit, and is navigable from Basel to the North sea. The lower Rhine serving the Ruhr valley is the busiest river in the world and Ruhrot-Duisburg is the greatest inland harbour. The Danube is also an important waterway.

In China river transport is of great importance and consists chiefly of rivers and connecting canals. The boats are, however, of the primitive type.

It may not be out of place here to give the following table showing details about the great ship canals of the world, for besides being used by ocean-going steamers, they also serve as useful inland water ways.

Canal	*opened in*	*length in miles*
Suez (Egypt)	... 1869	104·5
Albert (Belgium)	... 1934	80·5
Kiel (Germany)	... 1895 (reconstructed in 1914)	61
Panama (Panama U. S.)	... 1914	50·72
Elbe Tarne (Germany)	... 1900	41
Manchester (England)	... 1894	35·5
Welland (Canada)	... 1932	27·6
Amsterdam (Netherlands)	... 1876	16·5
Cronstadt-Leningrad	... 1890	16
Cape Cod (U. S. A)	... 1914	18
Corinth (Greece)	... 1893	4
Black Rock (U. S. A.)	... 1914	8·2
Sault Ste-Marie(U. S. A.)	1855	1·6
,, (Canada)	1895	1·11

2. *Ocean Transport* :—In 1937 the total mercantile marine of the world had 31,183 vessels of all descriptions out of which the various countries claimed as given below :—

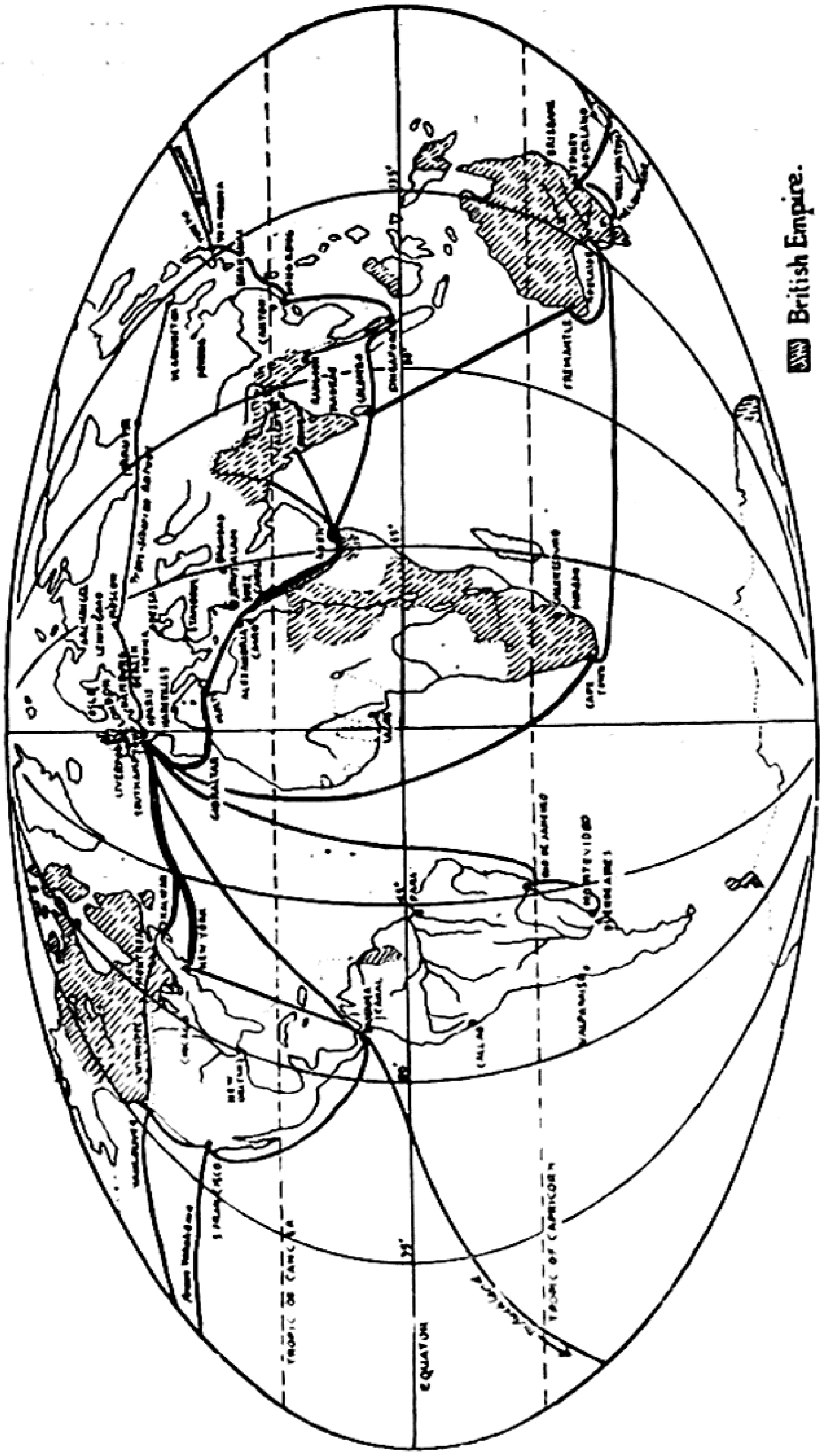

Fig. 23. Ocean Routes

U. K.	7,264
U. S. A.	3,485
Japan	2,564
British Dominions	2,447
Germany	2,191
Norway	1,901

France	1,366
Italy	1,270
Sweden	1,249
All others	7,546.

For many countries like Great Britain, ocean transport is vital because they are not self-sufficient and hence have to import food and raw material. Moreover for maintaining an empire, quick, cheap and efficient ocean transport is equally important. The map shows the main ocean routes of the world.

Logs hollowed out and pushed by poles provided the first boats. They were followed by oar-driven boats. Early Mediterranean people were the first to build large boats and such boats used to ply across the Mediterranean sea. The invention of sail was an useful improvement and the 15th, 16th 17th and the 18th centuries saw a lot of commercial development and explorations. The first steam boat crossed the Atlantic in 1819 and since then steam ships have tremendously increased in use and number so much so that only very few sailboats are seen to-day.

The chief ocean routes start from British ports (specially London, Liverpool and Southampton) and go either east ar west :—

(*a*) Those going eastwards through the mediterranean sea and Suez canal to India and the far east and to Australia and New Zealand. Before the construction of the Suez canal, ships used to go all the way round Africa via the Cape of Good Hope. The opening of the Suez canal therefore has greatly shortened distances as is evident from the following tables.

A

Distance saved	from Liverpool to	Bombay	4,541 miles
,,	,,	Batavia	2,689 ,,
,,	,,	Hong Kong	8,410 ,,
,,	,,	Sydney	391 ,,

B

Distance saved	from New York to	Bombay	3,409 ,,
,,	,,	Batavia	1,517 ,,
,,	,,	Hong Kong	2,298 ,,

(*b*) Those going southwards and eastwards down the west coast of Africa, round the cape of Good Hope and on to Australia and New Zealand.

(*c*) Those going towards the west across the Atlantic ocean. Some of these stop at the eastern ports of North America. Some are connected with the Trans-continental railways to the western coast from where routes start for Japan, Australia and New Zealand. Others pass through the Panama Canal and pass to the western coast of U. S. A. or South America or go on to Japan, Australia and New Zealand.

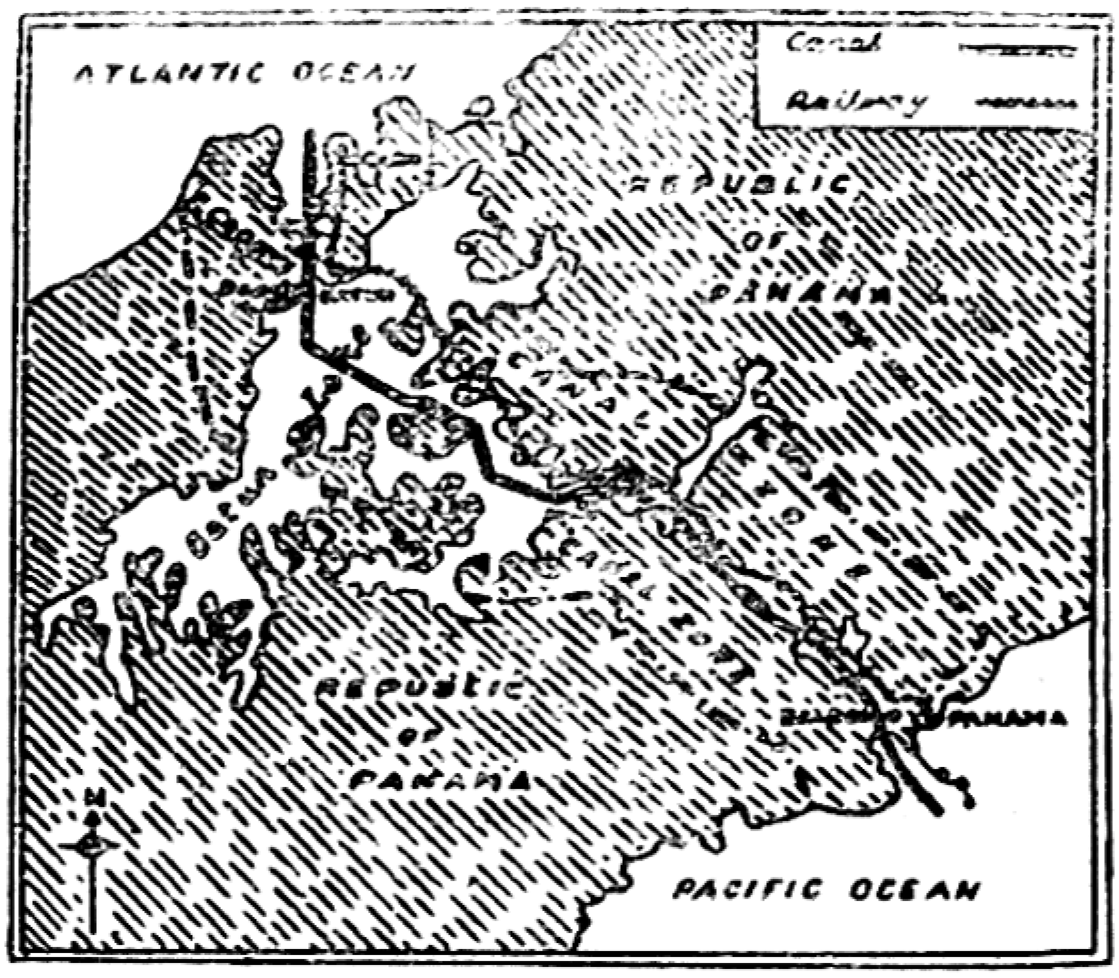

Fig. 24. Panama Canal.

The *Panama canal* has shortened distances between the pacific coasts of South America and the Atlantic coast of North America. Australia and New Zealand have been brought nearer to U. S. A. Europe has found a new route to Australia and New Zealand, although there is no appreciable saving in distance. Japan has been brought nearer to the Atlantic ports of North America. The following sets of figures are important.

(*a*) Saving of distance between New York and Valparaso by using the Panama route = 3,800 miles.

(*b*) Saving between New York and Sydney = 3,700 miles
(*c*) ,, ,, Wellington = 2,800 ,,
(*d*) ,, ,, Yokohama = 3,400 ,,

The greatest advantage to U. S. A. by the opening of the Panama canal, is that she can now defend both of her coasts with only one navy while formerly she required two.

Kiel Kanal

Kiel canal deserves mention as it is of tremendous strategic and commercial value to Germany. The Kiel canal connects the Baltic with the North sea and gives a continuous coast line to Germany, besides shortening distances between the German coast on the Baltic and that on the North sea. It has enabled Germany to protect her Baltic as well as the North Sea coasts with only one navy. After the last great war, the canal was made free to all nations. The same might be repeated after this war.

3. Air Transport

The Wright brothers made their first aeroplane flight in 1903, flying a distance of 800 feet. Air transport development has continued ever since.

Air routes now folllow important trade routes. The Imperial Airways of Great Britain and the Royal Dutch lines follow the Mediterranean route and link northwestern Europe with southeastern Asia, the East Indies and Australia. German and French fast services compete for traffic between northwestern Europe and southeastern South America, following the African coast and crossing the Atlantic Ocean at its shortest width. The latest addition to International air service is the clipper service between New York and England. The Pan-American airways of U. S. A., connect her with both east and west coasts of South America and with the lands bordering the Caribbean Sea. Trans-Pacific services were established in 1936, and now regular services to Manila and the Asiatic Mainland exist.

U. S. A. is most developed in the matter of internal air-transport. In 1937 she had about 31,000 miles of air-routes and during that year about 1,000,000 passengers and 17,060,000 pounds of mail were carried by American airways It may be surprising to learn that the world air-route mileage is about 32,000 miles, that is to say U. S. A. claims within its folds about 50 per cent of the air routes of the world.

All European capital towns are linked by air routes. The Cape-to-Cairo route has been established. Australia too has air connections within.

The following tables contain some useful figures.

(A) *Mileage of routes*

U. S. A.	...	71,200 miles	(1938)
France	...	41,000 ,,	,,
Germany	...	33,000 ,,	,,
U. K.	...	25,500 ,,	,,
India	...	6,700 ,,	,,

(B) *Freight and Mails carried*

U. S. A.	...	3,000 tons	(approximately)
Germany	...	2,500 ,,	,,
France	...	1,250 ,,	,,
Holland	...	750 ,,	,,
Great Britain	...	600 ,,	,,
Columbia	...	500 ,,	,,
Poland	...	275 ,,	,,
Italy	...	250 ,,	,,

CHAPTER XI

DISTRIBUTION OF HUMAN LIFE

Near about 2,000,000,000 (two billion) people live on the earth. All this population is very unevenly distributed. The average density of population on land is about 40 persons per square mile but if we calculate the density on the basis of the whole earth including both the water and land surfaces, the figure will be very low. Even the total population could be accomodated in an area about 434 square miles. The following table gives the land area of continents with their respective populations (1938-39).

Continent	*Area*		*Population*
Asia ...	16,000,000	sq. miles	1,280,000,000
Africa ..	11,500,000	,,	154,000,000
North America	9,000,000	,,	182,000,000
South America	7,000,000	,,	90,000,000
Europe ...	4,000,000	,,	510,000,000
Oceania ...	4,000,000	,,	11,000,000
Austarctica ...	5,000,000	,,	Few
Total ...	56,500,000	,,	2,227,000,000

Almost half the people of the earth live in Asia and the adjacent islands. Though the western hemisphere is equal in area to Asia, the population is only a quarter. This brings us to the question why places vary as to the density of their population. This is a combined result of physical, economic and political factors.

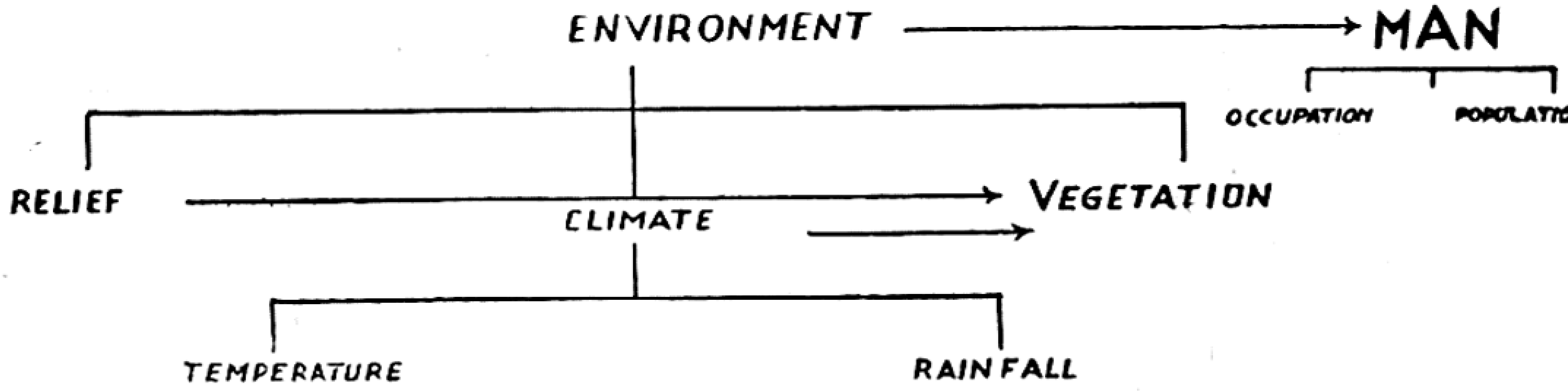

Fig. 25. Environment and Man.

(1) Physical factors include location, relief and the climate of the region concerned. Isolated and far-flung places do not attract much attention. Plains and valleys are more thickly populated. Both the extremes of climates are unsuitable for healthy settlement. The Tundras, the Deserts and the equatorial regions are equally unsuitable for large populations. The temperate and the monsoons regions with seasonal rainfalls are best suited.

(2) What nature has provided in the shape of soils, water, minerals, plants and animals also affect population distribution and density.

(8) "The third type of factor affecting population distribution and density is represented by man's accomplishments." At places he has made perfect use of the geographical factors while at others natural resources just lie untouched. These are cultural factors.

(4) Sometimes the distribution and the density of population are also affected by political or religious factors and position of trade routes.

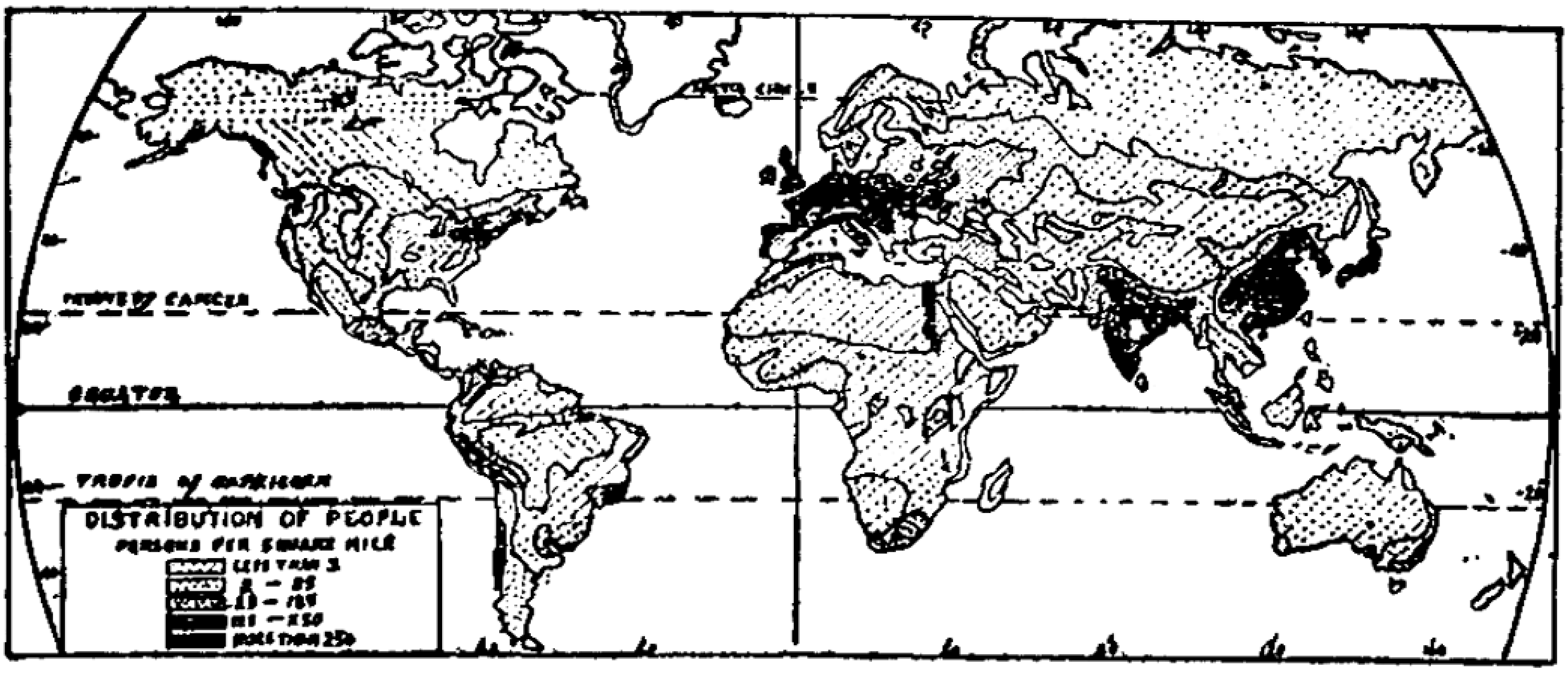

Fig. 26. World Distribution of Population.

The map shows the distribution of people per square mile.

A minute study of the map gives us four distinct divisions,[1] *viz.*, (1) Densely populated areas, (2) Moderately

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[1] The following table gives some typical population densities. A study of this will tell you how great are the variations from place to place :—

District of Columbia ...	7,852·7
Northern Egypt ...	1,119·8
Str. Settlements ...	742·7
Belgium ...	704·1
England and Wales ...	685·2

populated areas, (3) Sparsely populated areas and (4) Practically uninhabited areas.

1. These regions are either highly agricultural or highly industrial and commercial. The average density is 125 to 250. Good examples of agricultural regions are India, Northern Egypt and Eastern Chinese plains and valleys. On the industrial side Belgium, north-east U. S. A., England and Wales could be quoted. The greatest concentrations are in the villages in the case of agricultural regions (rural population), while most people in the industrial areas live in towns and cities (urban population). It is therefore, natural that the number of cities is greater in the case of the latter regions.

(2) Here the density is from 25 to 125. These districts are capable of supporting only moderate populations and hence it could be concluded that they are (1) inferior agricultural lands or (2) Grazing grounds or pastures and (3) inferior industrial areas. The valleys and plateaus of Spain, the American plateaus (tropical) and the better farming lands, the Balkans and the south-west of Asia are good examples of such areas. In South-eastern Asia such densities are found in drier and higher regions.

(3) Regions having a density of two to twenty-five may be included in this group. They are the transitional areas between the better and the worst regions. Poor grasslands, mountain slopes, the cool forested regions and the arid areas are included in this region. Central Africa and Northern Europe are good examples of this type.

(4) Regions having extremes either in relief or in climate have practically no people. The Tundras, the hot deserts and the high mountains are very thinly peopled. The dense equatorial forests are equally unsuitable for any habitation.

Races of man

Mankind may broadly be divided into three races, mainly based on physical differences (*i.e.*, head-form, nature of

---

Japan	...	**462·0**
China proper	...	**289·2**
British India	...	**245·8**
Zanzibar	...	**230·0**
Salvador	...	**119·5**
Manchuria	...	**81·8**
Uruguay	...	**27·6**
U. S. S. R.	...	**20·4**
Bolivia	...	**5·9**
S. W. Africa	...	**0·8**
Alaska	...	**0·1**

hair, stature, complexion and face features) :—

(*a*) Caucasian Race also called the White Race.

(*b*) Mongolians or Yellow Race.

(*c*) Negro or Black Race.

Some people also recognise the Malayan and the Red Indian Races.

The White Races live mainly in Europe, North Africa and South-west Asia. Many of them have now migrated to the tropical colonies, the Americas, Australia and South Africa. They are most advanced.

The Mongolians are indigenous to Asia and have their greatest concentrations in China and Japan and Tibet. They are also advanced in civilization.

The Negroes are found within the tropics chiefly in Africa. Some are also found in West Indies and Southern U. S. A. They were brought from Africa as slaves.

The Americas are the native place of the Red Indians, who are so called because of their copper colour.

The main religions followed by the people are (1) Christianity, (2) Hinduism, (3) Islam and (4) Buddhism.

There has been a great inter-mingling of races and religions because man has not stuck to the hard and fast rules of race and religion preservation. Emigration has always been an active factor of human society. Men have left their homes and gone to other lands in search for better prospects of livelihood. They have gone there and made the new lands their homes and the new people their relations and associates.

It may be useful to summarize the principal causes of emigrations. They are (as given by Evlyn Thomas).

(*a*) Overcrowded or improductive soil of the Home country. People from Europe have settled in the tropical colonies.

(*b*) Political and Religious differences and a desire or mental and spiritual freedom.

(*c*) The attractive prospects offered by a new land. People from Europe have gone over to the Americas, Australia, New Zealand and South Africa.

(*d*) Immigration schemes fostered by Governments.

· CHAPTER XII

GEOGRAPHY OF CITIES

Cities do not grow up everywhere or of their own accord. Natural environment greatly influences the location, growth and the development of every city. Some places are important because of political, religious or strategic factors. There are several towns, however, which are important because of more than one reasons.

The following types of cities may be recognised :—

(1) *Governmental cities including capitals of countries* are usually situated in central places, *e. g.*, Delhi. They are also commonly situated on the avenues of trade and commerce.

(2) *Resort cities* include hill-stations and sea-side places. They should be easily accessible. Mussoree in U. P. and Brighton in England are good examples.

(3) *Cities of Military importance* are those that guard the main routes to a country either by land or sea. Peshawar on the Khyber and Gibralter in the south of Spain, or Singapore are good examples. Singapore is called the *gateway* of the east. Hence it is quite important.

(4) *Holy cities* like Mecca, Hardwar or Ajmer owe their importance purely to religious considerations.

(5) *Industrial Towns* are usually situated near some

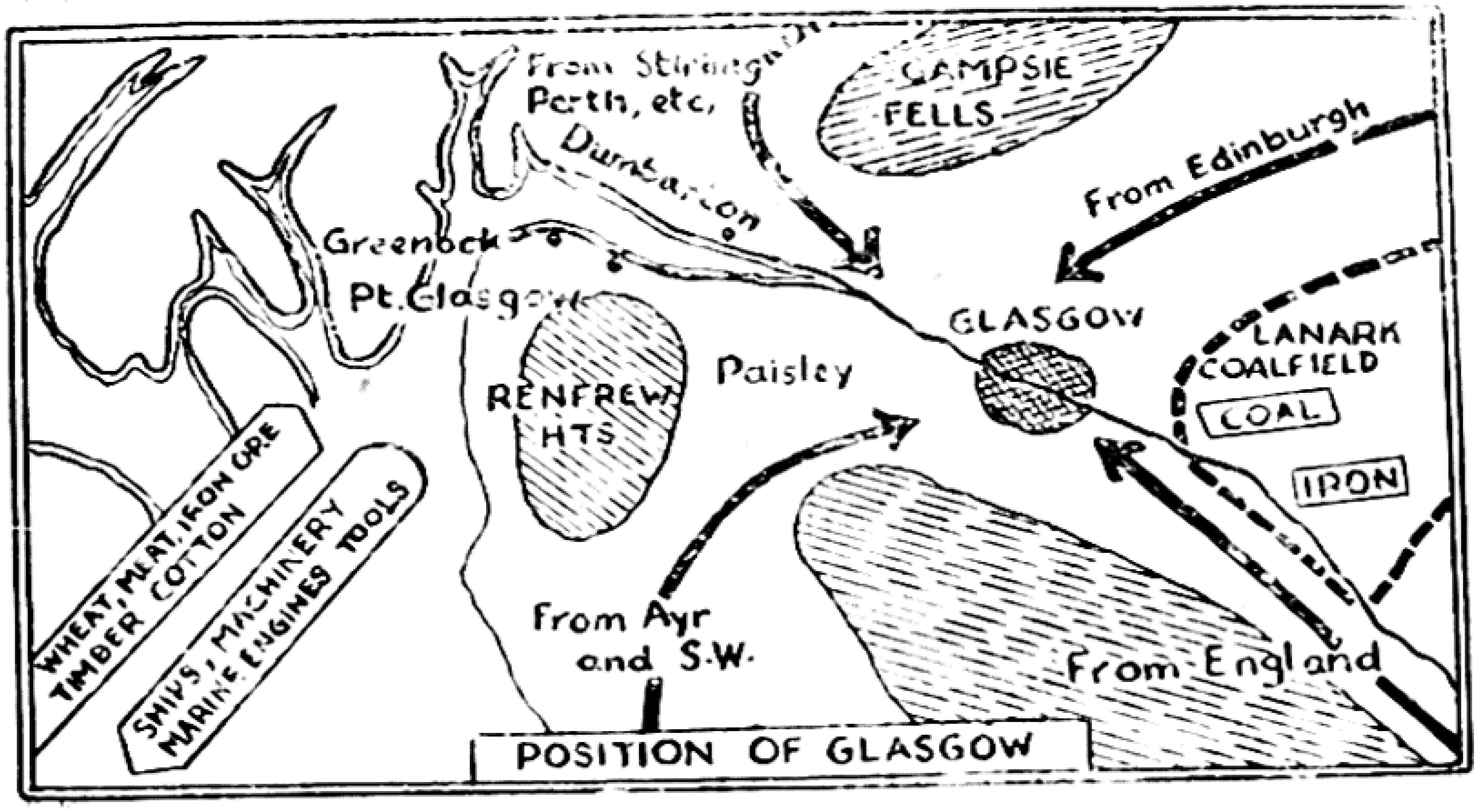

Fig. 27.

source of power and have good transport facilities. Glasgow as shown in the diagram is situated at the lowest easy crossing place of the Clyde and at the head of navigation for occean-going steamers. It is the natural focus of the routes of the region and has become a great industrial centre because of the supplies of coal and iron and the ease of importation of raw materials and the export of finished goods.

(6) *Commercial Towns* are usually situated in a rich region at the junction of several routes. These are really the gathering and distributing stations for the produce of the region. London, whose reputation as the biggest commercial town of the world is unrivalled and owes much of its importance to its excellent situation at the head of the Thames estuary. It is surrounded by rich agricultural and industrial areas and is the greatest railway and road-junction in the country. London is also very importaat as a port and receives about a third of the British imports and sends out about one fourth of the total exports. Winnipeg is an import wheat storing and selling town.

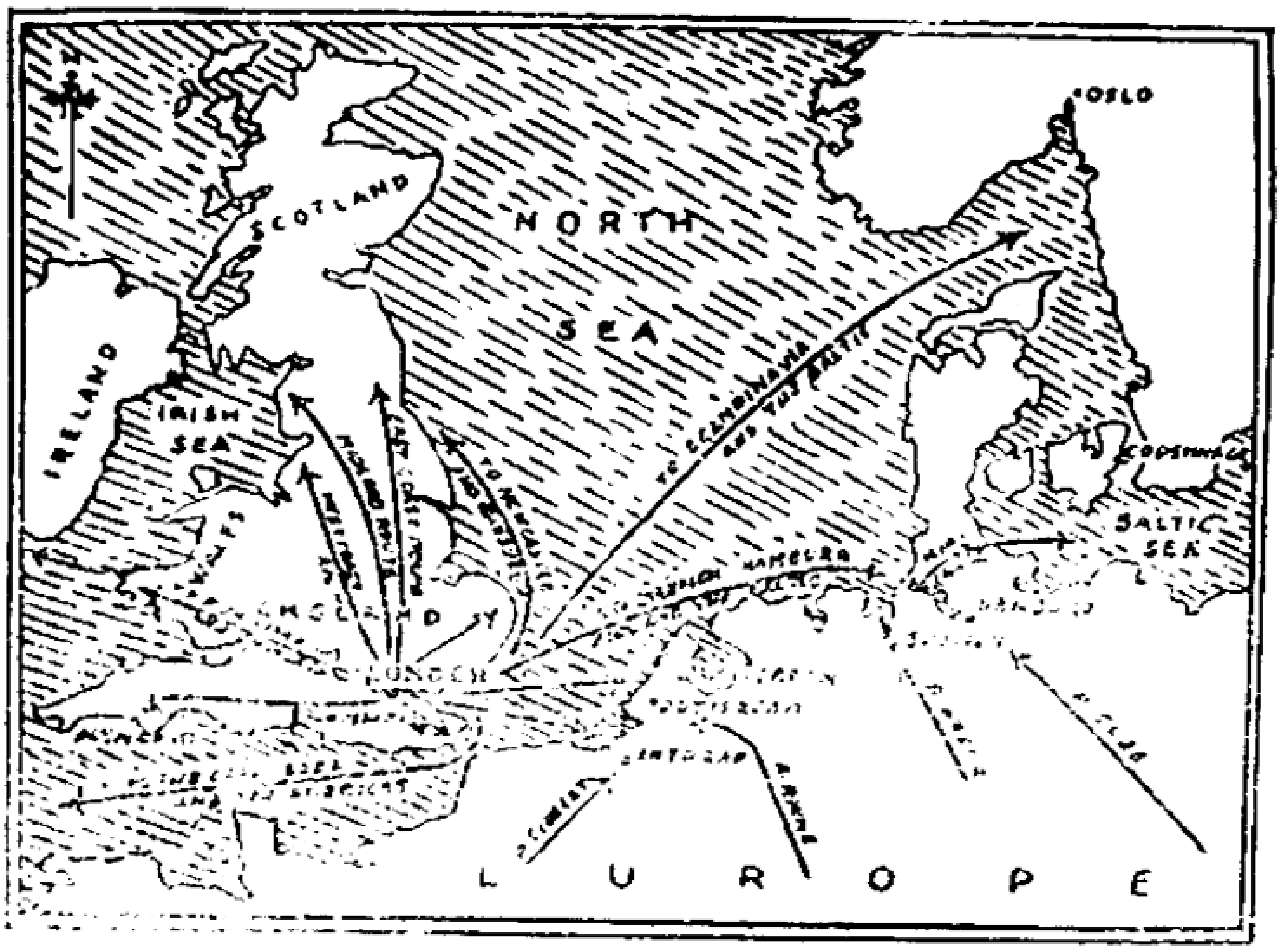

Fig. 28. Position of London.

(5) *Route Towns* are those who owe their importance to their positions on great trade routes (roads, railways or ocean). Singapore and Columbo are important route towns. Dublin is an important railway junction. Allahabad is important because here

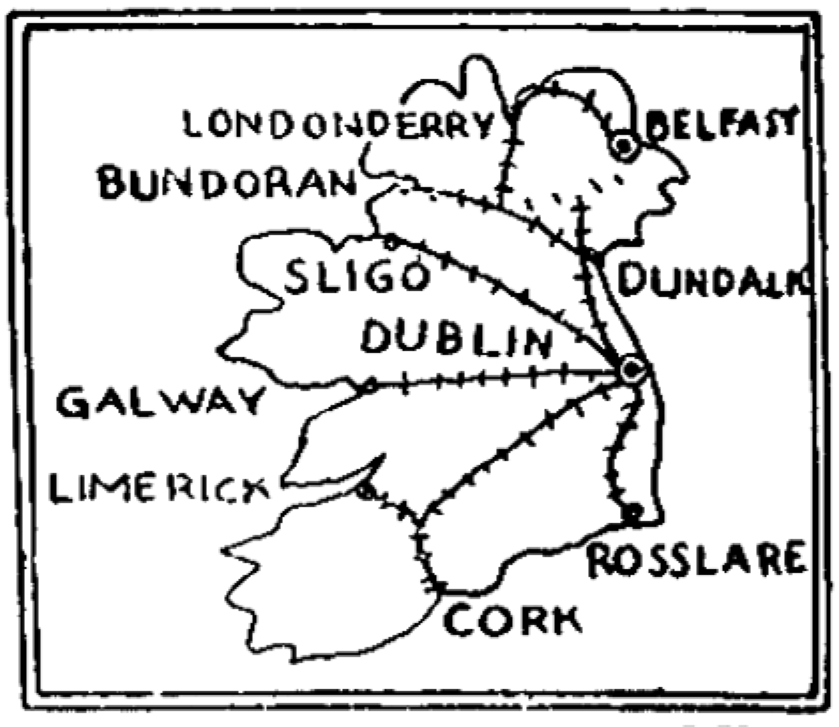

Fig. 29. Position of Dublin.

Ganges and Jumna, the two great highways of the past meet.

(6) *Mining cities* are important because of the presence of mines. They are usually situated near industrial places and have good communications.

(7) *Residential Towns*—Near about great industrial and commercial towns, grow up a number of residential towns as near London and New York.

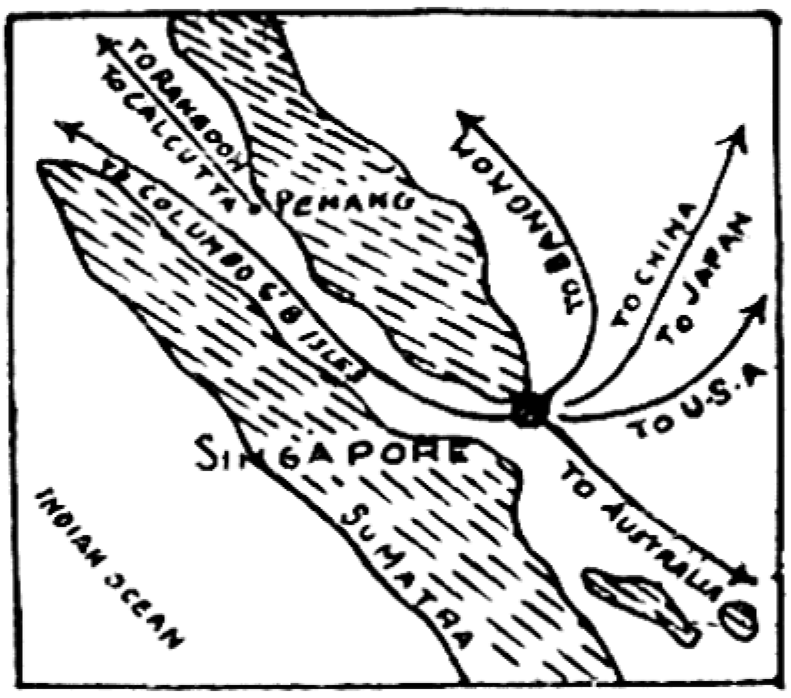

Fig. 30. Position of Singapur.

(8) *Air-ports* gradually gain in importance.

(9) Good *ports* should have (*a*) safe and good harbours (*b*) rich hinter lands, (*c*) good railway connections with the interior, (*d*) and they should be nearer world markets (*e*) and not situated away from the main ocean routes (*e. g.* Calcutta is not on the main route and hence is not so important as Bombay or Colombo.

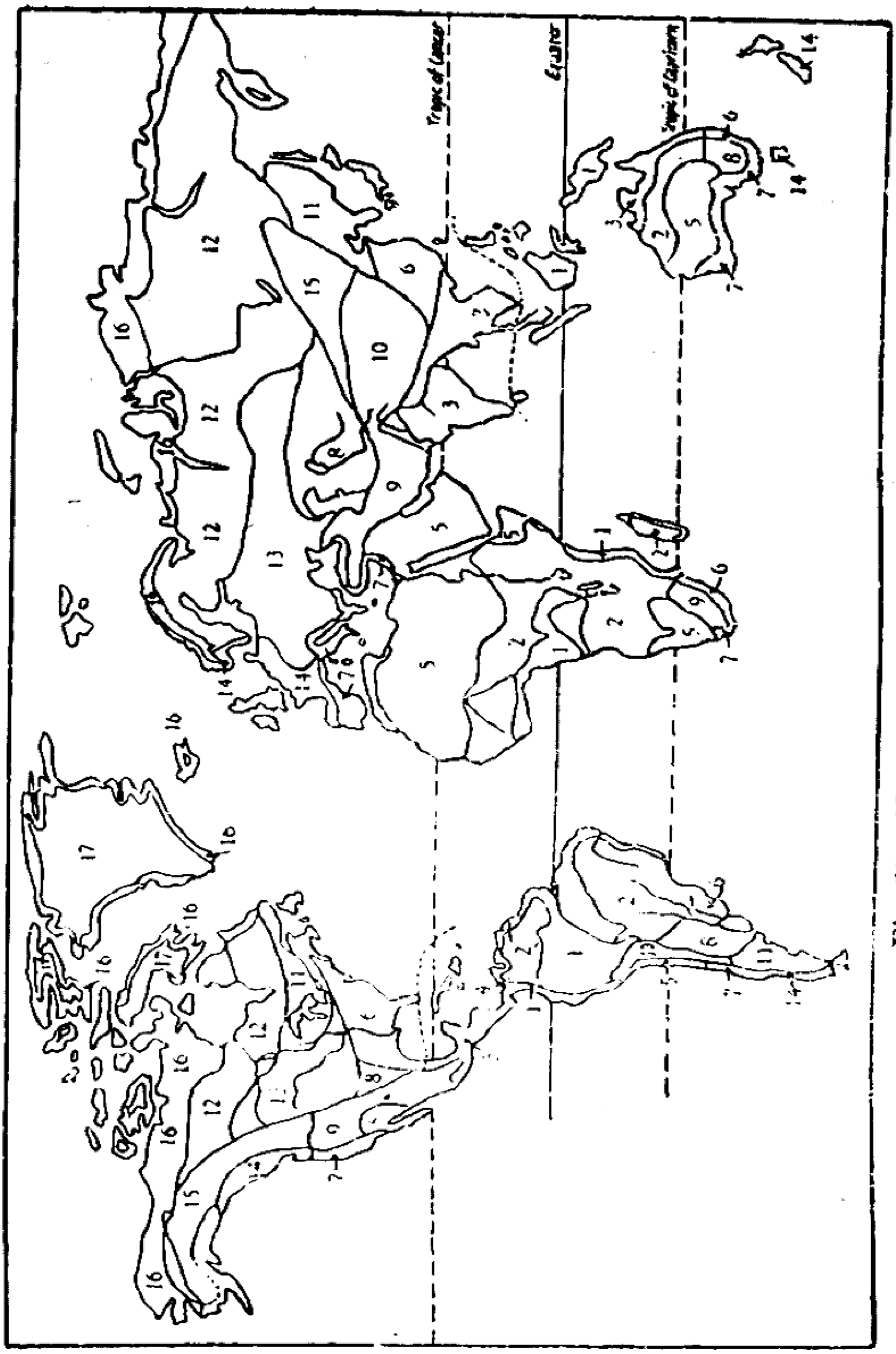

Fig. 31. Natural Regions of the World.

CHAPTER XIII

MAJOR NATURAL REGIONS

A major *natural or Geographical region* comprises all those areas of the world which contain uniform geographical characteristics, and as a result human activities found therein are also uniform. The world may be divided into the following Natural Regions :—

A. Hot Lands.

1. Equatorial region.
2. Regions of summer rains or the Savannas.
3. Tropical Monsoon areas.
4. High plateaus.
5. Hot deserts or the regions of the Sahara type.

B. Warm Temperate Lands

6. Eastern margins or the lands of the China type.
7. Western Margins or the lands of the Mediterranean type.
8. Interior lowlands.
9. Plateau regions of the Iran type.
10. High Plateaus.

C. Cool Temperate Lands

11. Eastern margins of the St. Lawrence type.
12. Cool Forests.
13. Cool Grasslands.
14. Western Margins of the Western Europe type.
15. Highlands.

D. Cold Lands

16. The Tundras.
17. The Cold Deserts.

The Hot Lands

1. The *Equatorial regions* comprise of land situated near the equator, extending to about 50° N and S (Amazon

Basin, the Congo Basin, Lower Guinea, East Indies and Malaya and the North-East margin of the Guianas in South America). Temperatures are uniformly high throughout the year (80°F average). Convectional rain falls at all times of the year, but the maximum occurs during the equinoxes. The vegetation consists naturally of dense forests with heavy undergrowth. The atmosphere there is all dark and sticky and therefore very unsuitable for human life. Most of the animals live on the branches of trees. Snakes and other poisnous worms abound.

Human activity is practically absent except on the outskirts and on river banks. In the Amazon basin wild rubber is important but it has fast dwindled into unimportance because of the popularity of plantation rubber.

The East Indies are famous for their rubber, and sugar-cane plantations because it is easier to clear small islands and because transport there is also easy.

The people are 'degenerate, stunted in growth and mentally incapable of development, the piggmies of the Congo and the Indians of the Amazon are typical of this region.

2. *The Savannas* or the Tropical Grasslands are situated on both the sides of the equatorial forests. The most typical areas under this type lie in the Sudan in Africa. Other areas under this group are British East Africa, Mozambique the Rhodesias and Angola in Africa, the lands situated immediately North and South of the Amazon Basin and a belt just south of the Northern Peninsula in Australia.

Temperatures are uniformly high—the annual range of temperature being only about 10°F. Rainfall takes place mostly during the summer season, winters being dry. During the rainy season, grasses grow upto about 10 to 12 feet.

The main occupation is cattle-rearing and the region stands very low in cultural and economic development. In the hotter and wetter areas groups of trees appear. The Savannas specially those in Africa abound in hoofed animals and also have carnivores like the leopard and the lion. Emu in Australia and the ostrich in Africa are important.

Stock-rearing is the chief occupation of the people but in places agriculture is also carried on. The chief crops are sugar-cane, maize, cotton and coffee (more specially in Brazil). Millets and ground-nuts thrive in the drier areas.

Towards the Northern Margins, desert conditions begin to appear and life becomes nomadic and difficult. The Savannas are often referred to as a '*Region of Effort*' *i.e.*, much depends on how man utilizes the potentialities of the soil.

The region is called by different names in different place;

(1) Llanos in Orinico Basin;

(2) Campos in the Brazilian highlands; and

(3) Sudan in North Africa.

3. The *Tropical Monsoon* lands are situated specially in India, Indo-China, Southern China and Northern Australia. The Monsoons or the variable winds are caused by the swing of the wind belts and the creation of a low-pressure belt in Central Asia during summer and of a high-pressure belt during winters. The summer winds come from the sea and hence give rainfall, while winter off shore winds are dry.

The temperatures are high during spring and summer and the winters are cool and dry. The annual range is fairly marked specially in places situated in the interior. The rainfall is very heavy during summer and at places exceeds even the 80″ limit. In places of higher rainfalls dense monsoon forests occur and they are somewhat similar to the tropical forests. In drier regions leave-shedding trees like the teak thrive. Most of these forests have, however, been cleared for cultivation and the monsoon lands are some of the finest agricultural lands in the world.

Chief wet-region crops are rice, tea, coffee and jute; while in the drier regions wheat, barley, cotton and sugarcane are the main crops. Irrigation is important in regions having lower than 40″ of rainfall.

The population is on the whole dense.

4. The *Equatorial High Plateaus* differ from the equatorial lowlands only because of the difference in altitude. Temperatures are somewhat lower but fairly uniform. The daily ranges are high. The rainfall is also less and does not fall throughout the year. The greatest expanse of such plateaus is found in South America on the plateaus of Ecuador and Colombia. The climate therefore is much more enjoyable and is nick-named as 'Perpetual Spring.'

Grasses are the chief type of vegetation and stock-raising (specially sheep and goats) is the main occupation of the people. Some agriculture is also carried on in some suitable spots, wheat and barley being the chief crops.

5. *Hot Deserts* (or the regions of the Sahara type) are situated near about the tropics and the high pressure belts (30°N and S) where the movement of the winds is downward. They are more pronounced on the western margins of the tropical lands getting the Trade-winds.

In the Southern hemisphere Hot deserts are found in :—

(1) The Atacama region of South America ;

(2) the Kalahari area in South Africa and

(3) the Western part of continental Australia.

In the Northern hemisphere deserts lie in the Colorado region of North America. the Sahara in Northern Africa, the Arabian peninsula and the Thar region in India.

The general outlook is sandy, dry and hot except in spots which are served by rivers *e.g.*, the Nile valley, where agriculture (specially cotton-cultivation) is extensively carried on.

Some of these areas are rich in minerals and thus have attracted large populations *e.g.*,

(1) Western Australia—gold in Kalgoorlie and Coolgardie ;

(2) the Western mountain states in U. S. A. (North America) ;

(3) the Atacama desert (South America) where a lot of copper and nitrates are obtained. Most of these mining centres have good transport facilities but taking the region as a whole, camel is chiefly used as the beast of burden.

Near sources of water some settlements have come into being and some cultivation is carried on to provide for local needs. In places specially in the South of Algeria, for example, artesian wells have been bored.

B. Warm Temperate Lands

6. *Eastern margins* (or the regions of the China type) are found between 30°N and S and 40°N and S. on the eastern margins of continents. The trade winds blow during summer and the anti-Trades blow during winter. The climate is characterised by hot rainy summers and cold dry winters.

The region includes parts of China and eastern U. S. A., Natal, South-eastern Australia and portions in eastern South

America. Japan and Northern China may also be included in this type—but they receive monsoon rains.

The natural vegetation is ever-green forests, the chief trees being walnut and laurel. Large areas have been cleared of forests and agriculture is carried on. On the high lands sheep and cattle are reared. The crops may vary with latitude and climatic details. Rice is mainly cultivated in damp, warm area. In drier and cooler regions wheat is the chief crop. On the hill sides tea is the main crop. Cotton is important specially in U. S. A. Other crops include sugar-cane, tobacco, maize and millets. Opium poppy is also an important item of agriculture.

The population is usually very dense in these areas—the Sino-Japanese region being one of the most densely populated areas in the world.

7. *Western margins* or the lands of the Mediterranean type are found in the same latitudes as No. 6, but they are situated on the western margins of the continents and get rainfall in the winter from the westerlies.

The greatest expanse of this type is found in lands bordering the Mediterranean Sea. Besides these, Central California, Central Chile, the extreme South-West Africa, the South-West of Eastern Australia and the North Island of New Zealand also fall within this group.

The vegetation is mostly evergreen forests and they are adapted to withstand the summer drought. In drier regions pastures are found and sheep and goat-rearing is chiefly carried on. Some of the forests have been cleared for cultivation. Cereals like wheat and barley grow well in regions where irrigation is carried on. Citrus fruit, vine and olive are important crops of these areas.

These are the lands of oldest civilizations; and arts and literature have developed mainly in these regions. The old Roman and Greek civilisations are even known to-day.

8. The *interior lowlands* of the warm temperate regions are also known as the regions of the Turan type, because its greatest extension is in the plains of Turan in Central Asia.

The climate is of the extreme continental type and the annual as well as the daily ranges of temperature are marked. Rainfall is low—at places even desert and semi-desert conditions are reached. These unpleasant climatic characteristics are due to their inland situation. Rainfall is seasonal and reaches its maximum during summer.

Grasslands supporting a number of sheep and goats are characteristic to these regions. It is only in some of the very favoured places that rainfall is high enough for plant-growth. Stock-rearing is the main occupation of the people. In drier areas people wander about with their flocks in search of suitable pastures and water-sources.

Some cultivation is carried on in favourable spots with the help of irrigation. The chief cereals are wheat, barley and maize. The Turan cotton is important. In the Murray Basin in Australia and in the Pampas of South America agriculture is more important. Fruit is also grown in favoured spots.

9. *Plateau regions of the Iran type* are places of only moderate elevation. The greatest expanse of this group is found in the plateaus of Iran and Asia Minor and the Tarain Basin. Their climate is different from that of No. 8. Only in as much as that they being higher in altitude are cooler in summer and colder in winter. Both are equally dry. The Rockies and the Sierra Nevada and parts of the Mexican plateau in North America, and the higher regions of South Africa (Veld) may also be included in this region.

The vegetation is scrub and poor grasslands and as such sheep and goats are the chief wealth of the people. In the valleys some cultivation is carried on with the help of irrigation. Fruit are also grown there. The Veld of Africa has longer grasses and there cattle and horses are also reared. Cereals like wheat, barley and crops like cotton, tobacco are the chief agricultural products.

The density of population as well as the level of civilization are both low.

10. *High plateaus* of the Tibbet type are higher than No. 9 and hence they are cold throughout. Their tablelands are mostly 'intermont' and hence they receive only very low amount of rainfall. Only in some 'sheltered valleys,' some agricultural activity is in evidence. The main possession of the people are flocks of sheep and goats and yaks. They serve both for food and for wool and also as the only means of transport.

Hardy cereals like millets and potatoes are the chief crops. Other animals important in this region are llamas, alpacas and vicunas. They are also important for their wool and transport capabilities.

C. Cool Temperate Lands

11. *Eastern Margins* of the St. Lawrence type include South-eastern Canada, North-eastern U. S. A. (Collectively

called the St. Lawrence Basin), Korea, Northern Manchukuo and Northern Japan. The climate is ordinarily cold but tending towards being extreme. The region comes in the Anti-Trade wind belt and they are off shore here. The rainfall, is low and cyclonic and the climate arid. The vegetation is poor, scrub and grassland and the main occupation is rearing wool sheep. The rivers are frozen in winters and some of the northern parts are ice-bound for several months in the year. There are valuable fisheries situated in the region and as such fishing is the main occupation.

Some agriculture is carried on in some of the cleared and climatically suitable regions where mixed farming and fruit-growing are carried on.

The St. Lawrence Basin in North America has greatly developed industrially and commercially. Manchukuo is also being exploited by the Japanese. Besides these two regions, however, this region is highly ill-developed.

12. *The cool forests*—It is a region which stretches as a broad belt across the Northern Hemisphere (in the northern parts of the continent). The temperature is low but the range of temperature is great. At certain places it is the greatest in the world. A special characteristic is that the days in winter are very short and the days in summer are very long.

Countries—1. Siberia in Asia.

2. Coastal strips of Norway and Sweden and northern Europe. Northern Russia excluded (extreme).

3. Canada, northern part of western North America and the central strip of Alaska.

4. Extreme south of South America.

5. The mountains of New Zealand.

Average yearly temperature is about 40°F. At certain places the average temperature may be below freezing point. A very well-known example is that of Verkhoyansk where the temperature is 59° in the coldest month. The average temperature is below freezing point. The summers are short but warm. The average for the hottest month is nearly 70°. At those places where the average temperature of the hottest months is above 60° wheat can be rippened. As the summer days are very long so grains get ripened in summer. Southern margins are comparatively warmer.

Most of the rain falls in the form of snow and it rarely exceeds 20″. Much of it falls during summer, lies in winter, and in the warmth of spring it melts and soaks into the ground. The evaporation is slight due to the low temperature, hence the ground gains the full benefit. A rainfall of 10″ is sufficient for the growth of the trees.

To the north of the deciduous forests and temperate grasslands coniferous forests of the cold temperate type are found. They are also called Taigas. The leaves are thick-skinned and cone-shaped. So they are able to face the intensity of cold and they offer hinderance in the loss of moisture. The forests are of ever-green trees. On the southern borders the forests are very thick but as we travel towards the north the trees become more scattered. The finest trees are grown in the warmer and wetter parts. These forests are world's great storehouses of soft timber. The forests of North America are very important in the world. In Europe there are the forests of Scandinavia and Northern Russia. These forests are also found on the hills and mountains of North-western and Central Europe. The forests of Northern Asia are inaccessible. The rivers flow northwards and during winter they are completely frozen. In the spring the ice melts in the southern parts but remains frozen in the extreme north with the result that water gets scattered and overflows the banks and thus helps in the growth of trees.

The lands are mostly undeveloped forests. The people who live in these forests are wild huntsmen who live on the flesh of animals, live in the huts made from the logs of wood and wear the clothes prepared from hides of the hunted animals. They also cut wood from the forests, drag it on the snow and take it to the harbours or to the storehouses in big cities. Wood pulp is also prepared which is used for making paper and artificial silk. Agriculture is possible on the southern fringes where wheat can be easily grown. Oats are grown in Canada. There is always a great danger of fire in the forests.

The animals have generally got thick fur on them. Wild bear is an example of the animals. They are killed and their fur is exported. People go out to the rivers for fishing. Some of them do dairy-farming.

13. *Cool grasslands* are found in interior lowlands specially in Canada and Siberia whence they go on into European Russia. The climate is cool continental and the rainfall is on the whole scanty sufficient only for grass to grow. In Canada there is a eastward decrease in

rainfall which in Siberia it decreases towards the west. The wetter parts are good agricultural lands like the Prairies of North America and the Steppes of Russia and are famous for their spring wheat, while in the drier regions sheep and goats and cattle are increasingly reared. Rye, oats and barley are some of the other important crops. The grasslands have correctly been described as the graineries of the world.

Wool, carpets and rags are important in South-Central Asia.

14. *Western margins of the western Europe type* are the most developed areas of the world. Their greatest expansion is in North-west Europe, British Columbia, Southern Chile, Tasmania and New Zealand.

The westerly winds bring tempering influences of warmer seas and temper the climates of these regions. Rainfall takes place throughout the year but is naturally higher in summer and decreases eastwards.

The vegetation varies from grasslands to deciduous and coniferous forests according to rainfall. Much land, however, has been cleared for cultivation of temperate cereals and vegetables like potatoes and sugar-beet. In the less fortunate parts, Dairy-Farming is important. In the forests regions of British Columbia lumbering is the chief occupation.

The climate is ideal for human activity and the variety of weather brought about by cyclones specially in Europe, is most stimulating for work.

15. *Cool temperate highlands* are found mostly in Asiatic and North American interiors. The North American highlands are on the western margins and hence rainfall is heavier on their western slopes ; while the Asiatic highlands are situated in the interior and are dry and have an extreme climate.

In North America lumbering and mining are the most important occupations. The Asiatic region specially Altai, is still undeveloped.

Cold Lands

16. *The Tundras.*—This region lies within the arctic circle. It remains frozen for more than nine months. The winters are very long and very cold.

This region includes the extreme north of Asia, extreme north of America and extreme north of Europe.

The temperature is very low during both summer and winter. It is like the temperature of the Cold Temperate lands. These lands remain frozen for about nine months. For certain periods the sun never rises and there is another period when the sun never sets but it never rises much above the horizon.

There is very little rain which falls in the form of snow. This snow only melts for two or three months in the year when it causes some moss and lichen to grow.

The cold is so intense that nothing can grow in this region except a little moss and lichen. In the southern parts there are flowery shrubs and grasslands. These grasslands have also been called "Arctic Prairies."

This region cannot be developed because the summers are too short to make anything grow. This is the reason why there are very few inhabitants in this region. Among the inhabitants are the "Samoides" of Asia, "Eskimos" of N. America and the "Lapps" of Europe. They keep the reindeer as the pet animal, drink its milk, eat its flesh, make clothes of its hides, live in the tents prepared from the hides of this animal and use it for drawing their "sledges." They prepare weapons from its bones and light their tents by burning the fat of this animal. Dogs are also found in this region. Among other animals are the Polar bear, Polar fox, Whale, wild Bison and seal. People hunt the Whale and the Polar bear.

17. The *Cold Deserts* situated beyond the Tundras are regions of perpetual ice and snow and hence attract but little human attention. The region is characterised by permanent low temperatures and no rainfall.

The weight of the collected ice and snow forces the marginal longer layers forward and the same break away into the oceans as icebergs.

The Antarctic continent and a major portion of Greenland and other islands may be included in this rigon.

The polar bear and the polar fox are the chief animals found ; seals, whales and walruses are also important.

Commercial Regions

1. **Main East Central North America** :—Northeastern United States and southeastern Canada comprise the great commercial region of east central North America. The United States have about 15 per cent of the world's foreign trade,

which is, however, lower than the foreign trade of Great Britain. But the United States is three-fourths as large as Europe, (including Russia) and nearly one and one-half times as large as western and southern Europe, not including Russia. In the United States, all shipments move as domestic commerce, freely across state boundaries of a territory much larger than all of central and western Europe. Thus the small size of European countries tends to increase the foreign trade of Europe, while the large size of the United States tends to increase its domestic trade.

Northeastern United States and southeastern Canada find much the same stimulus to commerce that Europe enjoys : extensive areas of good agricultural land ; abundant mineral resources ; good harbours on the Atlantic coast, the St. Lawrence River, and the Great Lakes ; favourable location for commerce, especially with Europe ; a dense and prosperous population ; a stimulating climate ; and an early start following the Industrial Revolution.

East central North America exports more food supplies and produces larger amounts of raw material for manufacturing in proportion to population, than central and western Europe. Manufacturing in east central North America absorbs available raw materials of lumber, iron, and agricultural products and sends the finished products to other regions of the United States and to foreign countries.

2. Central and Western Europe; The greatest commercial region of the world lies in central and western Europe. Various favourable factors operate to make this region one of outstanding commercial importance :

1. Central and Western Europe possesses extensive level and fertile lands, yielding a variety of food products sufficient for the support of a dense population.

2. This region has a good supply of mineral resources, including coal, iron, copper, lead, and zinc, thus aiding the progress of an energetic people.

3. The irregular coast line provides excellent harbours for great ports, such as London, Liverpool, Hamburg Rotterdam, and Le-Havre.

4. The location of Europe at the centre of the land hemisphere enables European merchants to carry on world trade within the shortest possible distance of shipment.

5. An invigorating climate encourages mental and physical activity.

6. The Industrial Revolution, beginning in western

Europe, gave this region an early start in world commerce, which it has steadily maintained and developed.

About 50 per cent of the world's foreign trade is handled by central and western Europe. Foreign trade embraces all shipment of goods from one country into another country for sale or trade. All commerce between the small countries of Europe is counted as the foreign commerce of those countries and of Europe. No country of Europe, except Russia, covers an area as large as the state of Ohio yet all commerce crossing their boundary lines forms a part of European foreign commerce. Nevertheless, the overseas trade of Europe is much greater than the overseas commerce of any other continent.

3. Southeastern Asia: Southern and eastern Asia, the third commercial region, is of less importance in world commerce than western Europe or the eastern North America. India supplies about 8 per cent of the world's foreign trade, the Malaya States 2 per cent, and the Dutch East Indies 2 per cent. These regions supply equatorial products wanted in areas of intermediate climates in Europe and North America. The foreign commerce of these areas is due largely to supervision by the Dutch, English, and French.

Japan, a newcomer in the industrial and commercial world, changed her policy from one of isolation, which she had followed prior to 1854, to one of inter nationalism. Japan now has modern machine factories and imports large quantities of raw material, such as East Indies rubber, United States cotton, and Chinese coal and iron. With cheap labour, Japan converts these materials into manufactured goods that have entered all the world's markets since 1920.

4. Other Commercial Regions: Other commercial regions lie in the subtropical and intermediate climates of the Southern Hemisphere. In South America, commercial areas exist in east central Argentina, which has 2 per cent of the world's foreign trade, and in southeastern Brazil, which has 1 per cent of the world's foreign trade.

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